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With METALLURGICAL SUPPLEMENT.

The Engineer.

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THE ENGINEER.

PLEASE MAKE A RECORD THAT ALL FUTURE COMMUNICATIONS SHOULD BE ADDRESSED TO:—

28, ESSEX STREET, STRAND, LONDON, W.C. 2.

The Engineer

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PUBLIC NOTICES

STEAM MAINS AND WIRING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on :—

(A) Monday, 16th June, 1930, for DISMANTLING OLD and INSTALLATION of NEW STEAM MAINS at H.M. Office of Works Generating Station, South Kensington, S.W.

(B) Tuesday, 17th June, 1930, for WIRING, &c., at the State Institution, Rampton, Retford.

Specification, copies of the conditions and forms of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea in each case. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5113

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

27 LOCOMOTIVE ENGINES and TENDERS, XA Type, 5ft. 6in. gauge.

Tenders due 17th June, 1930.

Forms of Tender available from the above at a fee of 5s., which will not be returned. 5129

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/2062.—SENIOR ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of PALESTINE for the Haifa Harbour Works Department. Salary £850 a year (the question of paying a salary up to £1000 a year will be considered in the case of a very highly qualified candidate). Free passages and house allowance. Candidates, 35 to 40 years of age, must be chartered civil engineers, must have a sound knowledge of design, also practical experience on construction, preferably dock and harbour works.

M/2191.—ENGINEER REQUIRED by the GOVERNMENT of HONG KONG for three years, with prospect of permanency. Salary £460 per annum, rising by annual increments of £20 to £500, and thereafter, in the event of the appointment being made permanent, by further annual increments of £20 to £700; then by £25 increments to a maximum of £1000, payable locally in dollars under compensation scheme at present in force at a favourable rate of exchange. Free passages. Candidates, unmarried, age 24 to 30, must be fully qualified Architects' Assistants, well up in building construction, including reinforced concrete work and drainage, and should possess one of the following qualifications :—A.M.I.C.E., A.R.I.B.A., F.A.S.I., or an exempting degree. Should possess a knowledge of law relating to buildings and public health easements and have had experience in the administration of Building and Public Health By-laws.

M/2176.—DISTRICT ENGINEER SURVEYOR REQUIRED by the Railway Department of the TANGANYIKA TERRITORY, for a tour of 29 to 30 months' service. Salary £840, rising to £920 a year by annual increments of £40. (A higher salary may be paid to a candidate with very high qualifications.) Free quarters and passages and liberal leave on full salary. Candidates, not over 45 years of age, must be qualified to take charge of reconnaissance and tacheometric railway survey parties. Must have had colonial or South American experience and knowledge of barometric and tacheometric surveys and of railway location and construction.

M/2015.—ASSISTANT ENGINEERS (12) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480 a year for the first three years, then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment and should preferably have attained the age of 22½ and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying Diplomas have been obtained without a College course should have had three years' practical experience of civil engineering under a qualified civil engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their Degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.

M/2174.—TWO ASSISTANT CONSTRUCTION ENGINEERS REQUIRED by the Railway Department of TANGANYIKA TERRITORY. Salary £600, rising to £720 by annual increments of £30. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, between 30 and 40 years of age, must have had considerable experience of railway construction in the Colonies or South America. Will be required to serve, as a rule, as Assistant to Resident Engineer on Construction by contractors, but must be able to act temporarily in the capacity of Resident Engineer.

M/2136.—ASSISTANT QUANTITY SURVEYOR REQUIRED by the GOVERNMENT of the TANGANYIKA TERRITORY for the Public Works Department for a tour of 20 to 30 months' service and possible extension. Salary £500 a year, rising to £600 a year by annual increments of £20. Outfit allowance of £30 payable on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 30, preferably unmarried, must be quick and accurate workers and be capable of measuring up and adjusting contracts on the completion of works and have had some years' experience with a recognised firm of quantity surveyors. Candidates holding the P.A.S.I. Diploma (Quantity Section) or similar qualification preferred.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 5135

PUBLIC NOTICES

Air Ministry. DIRECTORATE OF SCIENTIFIC RESEARCH.

A JUNIOR SCIENTIFIC OFFICER is REQUIRED for the Air Ministry's Scientific Research Staff, primarily for duty at the Royal Aircraft Establishment, South Farnborough, on Metallurgical Research.

Candidates should possess an Honours Degree in Metallurgy or equivalent qualifications, and should preferably have had training and experience in metallurgical research work.

Commencing salary £175 plus Civil Service bonus per annum, giving a present total starting remuneration of £265 19s. per annum, on the scale £175-£15-£235 plus bonus per annum.

The appointment will carry superannuation under the Federated Universities Superannuation Scheme. Government contribution being 10 per cent. of mean of scale, individual contribution 5 per cent.

Preference given, other things being equal, to ex-Service men.

Application should be made on a form to be obtained (quoting Reference No. A.409) from the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants, to whom it should be returned not later than 18th June, 1930. 5112

Derbyshire Education Committee.

APPLICATION is INVITED for the POST of LECTURER in ELECTRICAL ENGINEERING. The person appointed will be attached mainly to the Heanor Mining and Technical School, but will also be required to lecture at one of the other County Mining Schools. Salary in accordance with Burnham Scale for Teachers in Technical Schools. Forms of application may be obtained from the undersigned, to whom they must be returned, accompanied by copies of not more than three recent testimonials, not later than June 11th.

P. G. FEEK,
Director of Education.
County Education Office, Derby. 5068

PUBLIC NOTICES

Armstrong College.

NEWCASTLE-UPON-TYNE.

(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
4056 Newcastle-upon-Tyne.

The Technical College, Port ELIZABETH.

The Council invites APPLICATIONS for the POST of ENGINEERING WORKSHOP INSTRUCTOR.

Scale of salary for qualified and experienced man, £400-20-500.

Applications should be received not later than 24th June by Messrs. G. H. PENNEY and CO., 22, Lime-street, E.C. 3, from whom further particulars can be obtained. 5061

PUBLIC NOTICES

Administrative County of LONDON.

ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

APPLICATIONS are INVITED for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advance study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms (T3) 300 may be obtained from the EDUCATION OFFICER (T. 3), The County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1930.

MONTAGU H. COX,
4836 Clerk of the London County Council.

The University of Sheffield.

ASSISTANT LECTURESHIP IN MATHEMATICS FOR TECHNICAL STUDENTS.

The Council are about to APPOINT an ASSISTANT LECTURER in MATHEMATICS for Technical Students. Salary £300 per annum.

Applications should reach the undersigned, from whom further particulars may be obtained, by June 20th, 1930.

W. M. GIBBONS,
5106 Registrar.

Borough Polytechnic.

BOROUGH-ROAD, LONDON, S.E. 1.

LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING.

The Governors invite APPLICATIONS for the above-named APPOINTMENT, commencing in September next. The post is a whole-time one, and the duties include Day and Evening Work.

Works training, previous teaching experience with young students, and an Engineering Degree are essential.

Candidates having a special knowledge of Materials and of Engineering Metallurgy will be preferred.

Burnham Graduate Scale (£276-£528).

Form of application and conditions of appointment may be obtained by sending a stamped addressed foocap envelope to the undersigned. Completed forms to be returned not later than 16th June, 1930.

J. W. BISPHAM,
5121 Principal.

Belfast Harbour.

The Belfast Harbour Commissioners invite TENDERS for the CONSTRUCTION of certain TIMBER QUAYS and COLLATERAL WORKS, north-westward of the Dufferin-road, Belfast, in accordance with the specification which may be obtained on application from the Consulting Engineer, Mr. T. S. Gilbert, M. Inst. C.E., at the Harbour Office, Belfast, and in conformity with the contract drawings, which may be inspected at the office of the said Engineer, and from whom any further information required may be obtained.

Tenders, on the special form provided for the purpose, should be addressed to the undersigned and must be enclosed in a sealed envelope, endorsed "Tender for Quays, &c.," and delivered not later than Wednesday, the 25th June, 1930.

The Commissioners do not bind themselves to accept the lowest or any Tender.

M. J. WATKINS,
General Manager and Secretary.
Harbour Office, Belfast,
21st May, 1930. 5097

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

8018 COLD-DRAWN WELDLESS STEEL BOILER TUBES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Monday, 26th May, 1930.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Friday, 6th June, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. GRANT,
5090 Secretary.

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PUBLIC NOTICES

Borough of Richmond (Surrey).

WATERWORKS DEPARTMENT.
TENDERS FOR ELECTRICAL PUMPING PLANT.

The Corporation invite TENDERS for the SUPPLY and ERECTION of the following ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS with MOTORS, &c., complete :—

ONE VERTICAL-SPINDLE BORE-HOLE PUMP, with not less than 35 B.H.P. ELECTRIC MOTOR, capable of delivering 10,000 gallons per hour from a depth of 320ft.

TWO HORIZONTAL PUMPS, with not less than 80 B.H.P. ELECTRIC MOTORS, each capable of delivering 54,000 gallons per hour against a total head of 172ft.

TWO HORIZONTAL PUMPS, with not less than 65 B.H.P. ELECTRIC MOTORS, each capable of delivering 40,000 gallons per hour against a total head of 180ft.

TWO HORIZONTAL PUMPS, with not less than 10 B.H.P. ELECTRIC MOTORS, each capable of delivering 40,000 gallons per hour against a total head of 26ft.

Drawings may be seen and copies of the general conditions of contract, specification and form of Tender may be obtained from Mr. Hugh P. Williamson, M.C., M. Inst. C.E., Water Engineer and Manager, Hotham House, Heron Court, Richmond, Surrey, on deposit of a crossed cheque for £5 5s., which will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Electrical Pumping Plant," should be delivered to the undersigned not later than 10 a.m. on Wednesday, the 18th June, 1930.

The Corporation do not bind themselves to accept the lowest or any Tender.

EDWIN M. NEAVE,
Town Clerk.

Town Hall,
Richmond, Surrey. 5110

City and County of Kingston-upon-Hull.

TRAMWAYS DEPARTMENT.
SALE OF SECOND-HAND STEAM AND ELECTRICAL PLANT.

The Tramways Committee of the Hull Corporation invite TENDERS for the PURCHASE and REMOVAL of the whole of the PLANT installed at their Generating Station, Osborne-street, Hull.

Catalogues can be obtained upon application to the General Manager, Tramway Office, Albion-street.

Tenders to be received not later than 10 a.m. on Monday, the 16th June, 1930, endorsed "Power Station Plant," and addressed to the Chairman, Hull Corporation Tramways Committee, Guildhall, Hull.

The Committee reserves to itself the right to accept the whole or any portion of a Tender.

The plant may be inspected any day between the hours of 9 a.m. and 5 p.m.

E. S. RAYNER,
Engineer and General Manager.

Tramway Office,
Albion-street, Hull. 5122

City of Chichester.

SUPPLY OF FUEL OIL.

The Town Council of the City of Chichester invites TENDERS for the SUPPLY of suitable FUEL OILS for the Blackstone S.S.I.T. Cold-starting Heavy Oil Engine, 170 B.H.P., at the Waterworks Pumping Station, Fishbourne, near Chichester.

Also for suitable LUBRICATING OIL for the same Engine. The contract will be for one year.

Forms of Tender and other details may be obtained from the City Engineer, Mr. Frank J. Lobley, A.M. Inst. C.E., "Greyfriars," North-street, Chichester.

Tenders, in sealed envelopes suitably endorsed, to be delivered at my office not later than Noon on Tuesday, the 10th day of June, 1930.

The lowest or any Tender not necessarily accepted.

J. W. LOADER COOPER,
Town Clerk.

East-street, Chichester,
26th May, 1930. 5123

County Borough of Doncaster.

PUBLIC ASSISTANCE DEPARTMENT.
THE POOR LAW INSTITUTION, DONCASTER.

TENDERS are INVITED from responsible and experienced Contractors for the SUPPLY, ERECTION and SETTING to WORK of a CENTRAL HEATING APPARATUS, including Central Calorifier Plant, Mains, Radiators and Domestic Hot Water Heaters, together with Live Steam Services. Also the PROVISION of TRENCHES for MAINS, with incidental Builder's Work.

Specifications may be obtained and drawings seen at the office of the Consulting Engineers, G. J. Gibbs and Partner, 7, Lune-street, Preston, on deposit of the sum of £5, which will be refunded on receipt of a bona fide Tender and return of all documents.

Tenders, endorsed "Tender for Central Heating," to be delivered to the undersigned not later than 10 a.m. on Thursday, June 26th, 1930. The Council do not bind themselves to accept the lowest or any Tender.

Dated this 23rd day of May, 1930.

W. BAGSHAW,
Town Clerk.

Public Assistance Offices,
Wood-street, Doncaster. 5102

AMENDED ADVERTISEMENT.

County Borough of Doncaster.

PUBLIC ASSISTANCE DEPARTMENT.
THE POOR LAW INSTITUTION, DONCASTER.

TENDERS are INVITED from responsible and experienced Contractors for the REMOVAL of TWO 30ft. by 7ft. 6in. LANCS. BOILERS, and the SUPPLY and ERECTION of TWO NEW 30ft. by 8ft. 6in. LANCS. BOILERS, GREENS ECONOMISER, INDUCED DRAUGHT PLANT, PIPEWORK and AUXILIARIES, including the PROVISION of BOILER SEATINGS, ECONOMISER CHAMBER and FLUES.

Specifications may be obtained and drawings seen at the office of the Consulting Engineers, G. J. Gibbs and Partner, 7, Lune-street, Preston, on deposit of the sum of £5, which will be refunded on receipt of a bona fide Tender and return of all documents.

Tenders, endorsed "Tender for Boiler Plant," to be delivered to the undersigned not later than 10 a.m. Thursday, June 26th, 1930.

The Council do not bind themselves to accept the lowest or any Tender.

Dated this 20th day of May, 1930.

W. BAGSHAW,
Town Clerk.

Public Assistance Offices,
Wood-street, Doncaster. 5067

East Lothian Western District

WATER BOARD.
UNEMPLOYMENT RELIEF WORKS.
HOPES RESERVOIR—CONTRACT No. 1.

The above Board invite TENDERS for the PROVISION of a RESERVOIR and ANCILLARY WORKS, in the Hopes Valley, about five miles from Gifford, on the North British Railway.

These Works will include the excavation and Refilling with Concrete and Puddle, of the usual Trench across the Valley, and the formation of an Earthwork Embankment, with a Puddle Core, as well as the construction of a Discharge Tunnel, Valve Shaft, Waste Weir and Waste Watercourse, Meter House, short 15in. Pipe Line, and a Catchwater from Fall Burn to the Reservoir.

Plans and drawings may be seen, and copies of the specification, schedule and form of Tender obtained, on or after the 27th day of May, 1930, at the offices of Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester (except during Whit-week), on payment of a cheque for Five Guineas. A set of drawings will also be available for inspection at the Offices of the Water Board at Haddington. The sum aforesaid will, after the Board shall have come to a decision upon the Tenders, be returned to those parties who shall have sent in a bona fide Tender, shall have not withdrawn the same, and shall have returned the documents and drawings lent to them. A limited number of sets of the drawings (uncoloured) are available, and will be lent to parties tendering, in priority of application, upon receipt of a cheque for Three Guineas, which will not be returned.

Sealed Tenders, endorsed "Tender for Hopes Reservoir, Contract No. 1," must be forwarded to the undersigned on or before the 17th day of June, 1930.

GEO. CRUICKSHANK,
Clerk to the Water Board.

County Buildings, Haddington,
21st May, 1930. 5099

LEASE OF IMPOSING OFFICES FOR SALE.
33, NORFOLK STREET, STRAND, W.C. 2.

In consequence of the recent amalgamation of "THE ENGINEER" LTD., proprietors of "The Engineer," with MORGAN BROS. (PUBLISHERS) LTD., proprietors of "The Ironmonger" and "The Chemist & Druggist," the offices of the three journals will shortly be transferred to new and more commodious freehold premises which have been acquired at 28-31, Essex Street, Strand, W.C. 2.

The remainder of the lease, covering a further twenty-five years, of the present offices of "The Engineer" at 33, Norfolk Street, Strand, W.C. 2, is in consequence for sale. This particularly well lighted five-storey building has an area of 8,200 sq. ft., and occupies a site at the corner of Norfolk and Howard Streets, adjacent to the Temple Station, whence Westminster and the City may be reached in a few minutes. The building is of modern construction and has a fine and distinctive elevation. It is in good order throughout, and vacant possession can be had in June next. Rent £1,600. Moderate price. For further particulars apply to:—

WHATLEY, HILL & CO.,
24, Ryder Street, St. James', S.W. 1.

LEASE OF IMPORTANT CITY OFFICES FOR SALE.
42, CANNON STREET, E.C. 4.

In consequence of the recent amalgamation of Messrs. MORGAN BROTHERS (PUBLISHERS) LTD., proprietors of "THE IRONMONGER" and "THE CHEMIST AND DRUGGIST," with THE ENGINEER, LTD., proprietors of "THE ENGINEER," the offices of the three journals have been moved to new and more commodious freehold premises which have been acquired at 28-31, Essex-street, Strand, W.C. 2.
The lease of the entire premises, of which the four well-lighted upper floors have been in occupation of Morgan Brothers (Publishers) Ltd., the Ground Floor and Basement being sub-let to the Aerated Bread Co., Ltd., is in consequence for sale.
Alternatively, the four upper floors (which have also an entrance to Garlick Hill), having a total area of about 7,000 sq. ft. would be let.
The premises are in good order and vacant possession can be had in June next. Rent £2,000 per annum, inclusive of rates.

For further particulars apply to:

Messrs. FAREBROTHER, ELLIS & CO.,
29, Fleet Street, E.C. 4.

PUBLIC NOTICES

Coventry Corporation.

BROWNSHILL GREEN WATER SCHEME.
CONTRACT No. 4.
PUMPING MACHINERY.

The Corporation invite TENDERS for the complete INSTALLATION of a High-class PUMPING PLANT in DUPLICATE.

Each set will comprise a Vertical Electric Motor driving a combined High-lift Vertical Centrifugal Bore-hole and Force Pump to raise 30,000 gallons per hour against a head of 341ft., including friction, together with all ACCESSORIES, etc., to make the Plant complete in every detail.

There will also be ONE or TWO BOOSTER SETS for 15,000 gallons per hour working on a nett head of 90ft.

The work will also include subsidiary plant, including Depth Recorder, Venturi Meters, Heating Apparatus and General Equipment.

Copies of the conditions, specification, schedule of prices and form of Tender, may be obtained from the Engineer, Dr. Herbert Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, on or after May 28th, 1930. The application must be accompanied by a cheque of £3 payable to the Coventry Corporation, which will be refunded on return of the documents, or after the receipt of a bona fide Tender and the documents required.

Facilities for examining the drawings, for inspecting the Site and general information can be obtained on application to the Manager, Water Department, the Council House, Coventry.

Tenders are to be sent on the form supplied, and with the annexed documents must be enclosed in a sealed cover endorsed "Brownshill Green Water Scheme: Tender for Contract No. 4," addressed to and reaching the undersigned not later than 10 a.m. on Wednesday, June 18th, 1930.

Only Tenders for Vertical Electric Motors and Centrifugal Borehole Pumps from experienced manufacturers will be considered.

The Corporation do not bind themselves to accept the lowest or any Tender.

FREDERICK SMITH,
Town Clerk.

The Council House, Coventry,
May, 1930. 5089

Metropolitan Water Board.

TENDERS FOR THE MANUFACTURE, DELIVERY AND ERECTION OF ONE STEAM-DRIVEN CENTRIFUGAL PUMPING ENGINE (Capacity 10 M.G. per 24 Hours, Head 25ft.), AT KEMPTON PARK PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY, and ERECTION of ONE STEAM-DRIVEN CENTRIFUGAL PUMPING ENGINE at their Kempton Park Pumping Station, Hanworth-road, Sunbury Common, Middlesex.

Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of a fee at the Offices of the Board, Chief Engineer's Department (Room 173), on and after Monday, 2nd June, 1930.

Contractors desirous of tendering may obtain the necessary documents from the Chief Engineer on production of an official receipt for the sum of One Guinea, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings. Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Centrifugal Pump, Kempton Park," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 30th June, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
26th May, 1930. 5109

PUBLIC NOTICES

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES, &c., for the period of twelve months, commencing 1st August, 1930 :—

Tender No.
2. Brushes, Brooms and Handles.
5. Cotton Waste, Engine Wipers, Cleaning Cloths, &c.
6. Hemp, Yarn, Rope, House Flannel, &c.
10. Lead, Zinc and Glass.
13. Oilman's Sundries, Soaps, Tar, Gas Mantles, Metal Polish, &c.
14. Packings, Rubber Goods, Hose and Leather Belting, &c.
15. Paints, Varnishes, Linseed Oil, Turpentine, &c.
18. Scrap Iron—Purchase and Removal of.
24. Electric Lamps.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer, by personal application at the Offices of the Board (Room 155) or upon forwarding a stamped addressed sack envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board," and endorsed in the manner indicated in the form of Tender, must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Friday, 20th June, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
26th May, 1930. 5108

TO ENGINEERING CONTRACTORS.

The Corporation of Liverpool

invite TENDERS for the ENGINEERING WORK required at proposed Washhouse at Burroughs Garden Baths.

Plans, specification, and form of Tender may be obtained on application to the Baths Manager, 75, Dale-street, on payment of One Guinea, which will be returned on receipt of a bona fide Tender.

Tenders must be enclosed and sealed up in the official envelope provided, addressed to the Town Clerk, Municipal Buildings, Liverpool, and endorsed "Tender for Engineering," and delivered by letter post not later than 10 a.m. on Tuesday, the 17th June, 1930.

The Corporation do not bind themselves to accept the lowest or any Tender.

WALTER MOON,
Town Clerk.

Liverpool, 27th May, 1930. 5107

ELECTRICAL PLANT FOR SALE.

The Irish Free State Electricity Supply Board

have FOR DISPOSAL the following PLANT :—

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

The North London Tube Extension.

ON Tuesday, May 27th, a Select Committee of the House of Lords approved the preamble of the Bill promoted by the Underground Railways Company seeking powers for the extension of the Piccadilly Tube from Finsbury Park to Cockfosters. The measure has already passed through the House of Commons Committee. The Bill was opposed throughout by the London and North-Eastern Railway Company on the ground that the extension would jeopardise the financial returns which it anticipated would accrue to it from the electrification of its lines to Welwyn, Hertford, High Barnet, Edgware and Alexandra Palace. A resolution to undertake the electrification of these lines was passed by the Railway Company's board in March. The estimated cost of the electrification of the 60 miles referred to was £3,750,000. The railway company sought to have a clause added to the Underground Company's Bill to the effect that if the powers conferred by it were to remain in suspense until December 31st, 1930, and that if by that date the Railway Company had begun the electrification of its suburban lines from King's Cross, the Underground Company should not commence to exercise its powers under the Bill so long as the Railway Company proceeded diligently with the work of electrification and completed it within three years from the end of this year. It was also sought to provide that the powers under the Bill would lapse as soon as the Minister of Transport certified that electric working on the North Eastern lines had begun. This clause was not added to the Bill which, subject to the Royal Assent, now becomes operative in its original form. The Underground Company, it is intimated, proposes to have the contract ready for inviting tenders for the extension by June 15th, to start work at nine different points not later than September 1st, to have the section from Finsbury Park to Arnos-grove in operation in eighteen months from September 1st next, and to open the remainder from Arnos-grove to Cockfosters four months later. The cost of the extension is estimated at £5,335,000.

The Patent Office.

THE forty-seventh report of the Comptroller-General of Patents, Designs and Trade Marks shows that in 1929 the number of applications for patents continued to increase, and reached the record number of 39,898, or 1342 more than were received during the previous year. The receipts from patent fees amounted to £478,661, from designs fees, £11,759, and from trade marks fees £44,975, the total of which shows an increase of £33,466 over the corresponding total for 1928. On the expenditure side salaries absorbed £276,871, but there was a surplus of receipts over expenditure amounting to £157,005. The Patent Office, it will be seen, continues to earn a handsome profit for the nation. The Comptroller-General, commenting on the trend of inventions, states that while no very outstanding development can be detected, the year was marked by steady progress, particularly in the chemical and electrical sections. Great activity was shown in the application of cellulose derivatives for treating fabrics or for imitating natural products. Applications connected with fertilisers were four times as numerous as they were four years ago. In the electrical section, inventors paid great attention to lamps for general lighting, advertising, and therapeutic purposes. Photo-electric cells for use in talking picture apparatus and thermionic valves for radio and other uses also attracted much attention from inventors. There was an increase of nearly 50 per cent. in the applications concerned with wireless circuits and with television. Inventors continued to show great interest in coin-freed automatic machines, one direction to which particular attention was given being the devising of means whereby the apparatus shall only work on the insertion of a genuine silver coin of the proper value.

The Britannic's Wireless Installation.

ONE of the first new ships to be affected by the regulations of the 1927 International Radio Telegraph Convention of Washington, and by one regulation in particular, which restricts the power of spark transmitters fitted after January 1st, 1930, to 300 watts, is the White Star liner "Britannic." Throughout its history the White Star Line has been one of the first to take advantage of new developments, and in designing the "Britannic's" wireless equipment particular attention was paid to international regulations, not only of the Washington Convention, but also of the 1929 Safety of Life at Sea Convention. The Marconi wireless installation, which has been placed in a spacious room, includes a valve transmitter and receiver, an emergency transmitter, and a direction finder, and two motor lifeboats are also fitted with Marconi transmitters and receivers. The main transmitter is a valve installation for continuous and interrupted continuous wave signalling on 600 m. and 800 m., and for continuous waves only on wave lengths between 1887 m. and 2725 m. The two-valve receiver is a new development in marine work, as it covers the whole commercial wave band of from 15 m. to 20,000 m., for which two receivers were previously used. In connection with the "Britannic's" trials off the Clyde, an interesting experiment has been permitted by the Post Office. Temporary wireless telephone installations have been fitted in Harland and Wolff's offices and on the ship, so that representatives of the owners and builders can be constantly in oral communication during the three-days' trials. This experiment has never been attempted before, and will be watched with interest by all who know the endless questions which arise on these occasions, and which can usually be settled by a few minutes' talk by telephone.

Artificial Daylight.

IN Technical Paper No. 10 of the Illumination Research Committee, issued this week by the Department of Scientific and Industrial Research, particulars are given of a prolonged series of tests made to determine the relative merits of "artificial daylight" electric lamps and ordinary tungsten filament vacuum lamps as sources of illumination for clerical work. The evidence of the tests is held to show that the artificial daylight lamps are superior. The Committee seems to be quite satisfied on that point, but the evidence which it provides does not appeal to us as being wholly convincing. Indeed, the main impression which the report leaves us with is a sense of the difficulty of obtaining any trustworthy evidence in favour of one form of illumination or the other, and, having obtained it, of interpreting it in an unbiassed manner. The first series of tests consisted of obtaining the opinions of eighteen clerks working in groups of three for a week each in a room variously illuminated. Fourteen of the eighteen clerks gave preference to artificial daylight lamps when arranged to shine from the outside through a window covered with transparent paper, and placed last in their order of preference illumination by vacuum lamps arranged for semi-indirect lighting inside an opal glass bowl suspended from the ceiling. When, however, an attempt was made to pass from opinions to a numerical basis for the preference, the somewhat emphatic evidence of the first series of tests was upset. Three clerks were detailed to perform repetition work, consisting of the checking of slips, with the room illuminated in different ways. The average hourly output was taken as a measure of the suitability of the illumination. On this basis the artificial daylight window was placed at the foot of the list. The vacuum lamps in semi-indirect fittings practically tied for first place with artificial daylight lamps similarly arranged. The positions of the clerks' seats and tables were thereupon altered slightly, with the result that the artificial daylight semi-indirect system was placed first on the list, the artificial daylight window second, the vacuum lamp window third, and the vacuum semi-indirect fourth. We have little doubt that if some other variable had been changed—say, the colour of the walls of the room or the clerks' diet—yet another order of merit would have been indicated.

The New South Shore Bridge at Montreal.

THE new South Shore Bridge at Montreal, which connects that city with the suburban districts on the south shore of the river St. Lawrence was officially opened on Saturday last, May 24th. The ceremony was performed by the Canadian Prime Minister, Mr. Mackenzie King, who pressed a button in his office at Ottawa, and delivered the inaugural speech by telephone. The approach to the bridge on the Montreal side consists of a viaduct about 2300ft. in length, which begins at ground level and slowly rises to the point where it joins the main span. The span is of the symmetrical cantilever type, with an overall length of 1937ft., and there is a clear navigation channel of 1000ft. The navigation clearance in the channel at mean high water level is 155ft. on a central length of 500ft. On the south side of the river the approach extends from the main span for 900ft. to a pavilion erected on St. Helen's Island, and changing its alignment in an easterly direction continues a further 4000ft. to the southern shore. The whole bridge is about 1¾ miles in length and about 36,000 tons of steel have been employed in its construction. The contract for the bridge was originally let to the Dominion Bridge Company in 1925 at a price of about £2,000,000, but owing to increased prices for steel and to other reasons the final cost will not be far short of £3,600,000. The superstructure was actually completed in October last.

The Paris Fair.

THE scant participation of British industry in the Paris Fair would suggest that British manufacturers attach little importance to the value of the gathering as a means of reaching foreign buyers. The same view is not entertained by their foreign competitors, who readily took advantage of the occasion to bring their goods to the notice of users over a large part of the Continent. The Fair does not interest merely French buyers, the total number of foreign visitors being considerable. For many years there was reason to doubt whether engineering firms would find it to their interest to exhibit at the Paris Fair, but it is now abundantly clear that British manufacturers run the risk of letting continental markets slip entirely out of their hands through allowing foreign competitors to dominate the Show. In all the sections there was a strong foreign element, but in none of them were French machinery makers absent. While the French machinery industry has grown considerably of late years, there is still a good market in France for many classes of foreign machines. If British machinery firms remain practically aloof from foreign exhibitions, they probably have their reasons for doing so. They may perhaps argue that the British Industries Fair and the Olympia Machinery Exhibition are sufficient for their needs. The Germans have the Leipzig Fair, but they were in strong force in all the sections of the Paris Fair. They apparently did well, in common with many other exhibitors, for a large number of machines were ticketed as sold. There is an impression that with the wages paid in Great Britain, the prices of machines are necessarily too high to compete in a protected market, but tariffs do not keep out German, American, Swiss, and Belgian manufacturers, and while British makers may find it difficult to do business in highly competitive machines, there are many productions that could be sold if presented to buyers under suitable conditions.

The Birth of Wireless.

ON Tuesday last Dr. W. H. Eccles delivered his presidential address to the Institute of Physics, and took as his subject the influence of physical research on the development of wireless. The experimental demonstration given by Hertz in 1888 of the physical existence of electric waves, Dr. Eccles explained, was the foundation of wireless, but Hertz's apparatus was insensitive and the detectors discovered by Lodge, Branly and Minchin in 1889 and 1890 were essential to any prospective practical application. After those purely scientific investigations had proved the means and materials, wireless telegraphy was born at the British Association meeting at Oxford in 1894 when Lodge sent Morse signals from a spark apparatus worked by a telegraph key and recorded them on a moving paper tape by receiving apparatus at a distance. In 1899 Lodge introduced the method of tuning aerials by induction coils, thus enabling each transmitting station to correspond with a selected receiving station tuned to it. Another laboratory product was the arc generator of continuous waves, developed by Duddell and Poulsen, which led the way to wireless telephony, and in 1907 the human voice was heard across the Atlantic. The amplifying valve, which came into existence in 1913, was purely the work of physicists, the use of the grid being traceable to the experiments of a German physicist in 1902. The advent of the valve resulted in the scrapping of the great spark stations which had been laboriously developed during the fifteen years of pioneer engineering work, and also the popularisation of wireless telephony in the form of broadcasting. The physicist, Dr. Eccles explained, was better equipped than others to forecast in some degree the direction of forthcoming change and to assist in deciding the instant and mode for standardising and for modifying.

The New Cunard Liner.

CONSIDERABLE satisfaction is felt in the Clyde and Sheffield districts in the selection by the Cunard Steamship Company, Ltd., of John Brown and Co., Ltd., of Clydebank and Sheffield, as the builders of the new express liner for the Cunard service between the Channel ports and New York. Naturally, some weeks must elapse before certain vital questions now under consideration can be finally decided, thereby enabling a contract to be signed and the necessary materials ordered. The construction of the new liner, it is expected, will occupy about three years. No official announcements have yet been made concerning the dimensions of the new liner or the type of her propelling machinery. From unofficial forecasts, however, we gather that a ship of about 75,000 tons displacement with a designed speed of about 30 knots is being considered. There will be accommodation, it is suggested, for about 4000 passengers, with about 800 officers and crew. The cost of the new liner has been mentioned as probably between five and six million pounds. No official information is available concerning the propelling machinery, but it seems likely that geared turbines with high-pressure water-tube boilers will be favourably considered. It may be recalled that John Brown and Co., Ltd., recently received an assurance from the Clyde Navigation Trust that in the event of the order for the new liner being placed at Clydebank the necessary dredging operations at the mouth of the river Cart, opposite the yard, would be undertaken in order to allow the required depth for launching a ship over 1000ft. in length. John Brown and Co., Ltd. have constructed many noteworthy liners for the Cunard service, including the "Lusitania," the "Aquitania," and the "Franconia." In view of the financial changes in the firm referred to in our Sheffield letter to-day, we express the hope that the placing of the order for the new Cunard liner may mark the beginning of a new period of enhanced and profitable construction at this world-famed Clyde shipyard and engine works.

The Automatic Stabilisation of Ships.

No. IX.*

IN the preceding article it was shown that an oscillating gyroscope would impart complete stability to a ship if the precessional velocity was controlled by the application to the gyroscope about its transverse or precessional axis of a moment fluctuating in value between $8\,C\,r\,I'/\dot{\phi}\,I\,T$ in one direction and the same amount in the opposite direction. With this controlling or precessional moment in action, it was found that the amplitude of oscillation of the gyroscope would be $\pm\alpha$, where α, in radians, has the value $\frac{1}{8}\,C\,r\,g\,T/\dot{\phi}\,I$. These expressions are approximate only, but they tell us much that we desire to know almost as truthfully as do the exact expressions which can be established.

Let us consider first the implication of the fact that the amplitude of oscillation of the gyroscope is from $\frac{1}{8}\,C\,r\,g\,T/\dot{\phi}\,I$ of forward tilt to an equal angle of backward tilt. Since the quantity C is fixed by the dimensions of the ship, since $\dot{\phi}\,I$ is not variable once the gyroscope has been designed and installed, and since r is the ratio of the height H to the length L of the waves, we may write this amplitude as $\alpha=Q\,H\,T/L$, where Q is a constant for a given ship and a given gyroscope. Let us suppose that we decide to fix the amplitude at 60 deg.—that is, 30 deg. on each side of the vertical—when the ship is exposed to the standard wave of period 6·28 seconds, of length 200ft., and of height 10ft. It is evident that if the ship encounters a train of waves of the same period and length as the standard wave, but of twice the height, the amplitude of oscillation of the gyroscope will increase to twice its former amount—that is, to 60 deg. on each side of the vertical. In general, then, the amplitude will increase or decrease proportionately with the magnitude of the waves encountered. In contrast to the continuously rotating gyroscope, which if the speed of spin $\dot{\phi}$ is constant, could stabilise the vessel only on waves of one particular magnitude, the oscillating gyroscope will give complete stabilisation on a wide range of waves by automatically varying its amplitude to suit the magnitude of the waves.

There is obviously a restricton to the size of the waves with which the gyroscope can deal. If the equipment is designed to give an amplitude of $\pm$30 deg., when the ship encounters the standard wave—for which H T/L has the value 0·314—then, should she encounter waves for which H T/L has the value $3\times0\cdot314$, the amplitude of oscillation will be $\pm$90 deg. The oscillation must not, as we have already seen, exceed 90 deg. if complete stabilisation is to be given at all instants. Hence, for this case, the maximum magnitude of the waves with which the gyroscope can deal is one for which H T/L has the value 0·942.

It is worth while noting that so far as the amplitude of oscillation of the gyroscope is concerned, the "magnitude" of a wave train is to be judged by the compound factor H T/L, and not solely by the height of the waves. For example, a wave of 100ft. length—half that of the standard—would have a period of about 4·4 sec., and therefore if its height were a little over 7ft.—or, say, three-quarters of the standard—its "magnitude" H T/L would be equal to that of the standard wave.

In saying that the amplitude of oscillation of the gyroscope will adjust itself automatically to the magnitude of the waves, we are assuming that when the magnitude of the waves changes, the controlling or precessional moment will undergo any adjustment that may be required to suit the new conditions. This moment has, as we have seen, to rise each quarter period from zero to a maximum value of $8\,C\,r\,I'/\dot{\phi}\,I\,T$ or fall from that amount to zero. Separating the factors as fixed by the design of the ship and the gyroscope from those determined by the waves, we can write this maximum value as $S\times H/L\,T$, where S is a constant. If, then, the maximum precessional moment required when the waves are of the standard type, is, say, M_s, it is evident that should the ship encounter a train of waves of twice the standard height, the length and period remaining unaltered, the maximum precessional moment required will be $2\,M_s$.

The maximum precessional moment required, therefore, varies with the "magnitude" of the waves. It will, however, be noticed that the "magnitude" of the waves affecting the size of the precessional moment, namely, the compound factor H/L T is not the same as the "magnitude" H T/L affecting the amplitude of the oscillation. This fact is of much practical significance, for it rules out the possibility of varying the size of the precessional moment required to suit different waves by relying in some automatic manner on the size of the amplitudes appropriate to the waves. As an example, let us consider the simple expedient adopted by Schlick of applying the precessional moment by means of a weight of fixed amount attached to the gyroscope frame at an invariable distance below the precessional axis. The distance being h and the weight W, as shown in Fig. 27, the precessional moment applied to the gyroscope at any angle of tilt will be $W\,h\sin\varphi$. It will be zero when the axle is vertical and will rise to a maximum value $W\,h\sin\alpha$ when the tilt reaches the limit α of the oscillation. The precessional moment supplied by the weight will oppose the movement of the gyroscope forward or aft away from the vertical and will assist the gyroscope to recover the vertical position from either of its extreme angles of tilt. The essential features given by this system of applying the precessional moment are therefore in apparent conformity with the requirements.

Let us suppose, however, that the equipment is designed in such a way that on the standard wave the oscillation of the gyroscope is 30 deg. on each side of the vertical. On the standard wave—T=6·28 sec., L=200ft., H=10ft.—the quantity H T/L has the value 0·314. The formula for the amplitude of the gyroscope therefore gives us $\alpha=\pi/6=0\cdot314$ Q. On the standard wave the quantity H/L T has the value 0·008. The formula for the maximum precessional moment required for complete stabilisation therefore gives us $M_s=0\cdot008$ S. Let us now suppose that the vessel encounters a sub-standard wave train, one having a period, say, of 4·4 sec., a length of 100ft., and a height of 7·14ft. The quantity H T/L for this train is again 0·314, so that the formula for the amplitude gives us $\alpha=0\cdot314$ Q. Since Q involving only the dimensions of the ship and the size and speed of the gyroscope has not changed, it is evident that the amplitude corresponding to complete stabilisation is again 30 deg. On the other hand, the quantity H/L T is now 0·016, or twice as great as previously. The formula for the maximum precessional moment required therefore gives us $M'_s=0\cdot016$ S. The maximum angle of tilt is the same in both cases, but the maximum precessional moment required in the second case is twice that in the first. To effect the increase, we would have to increase either the distance h in Fig. 27 or the counterweight W. It is evident, then, that a fixed weight at a fixed distance beneath the

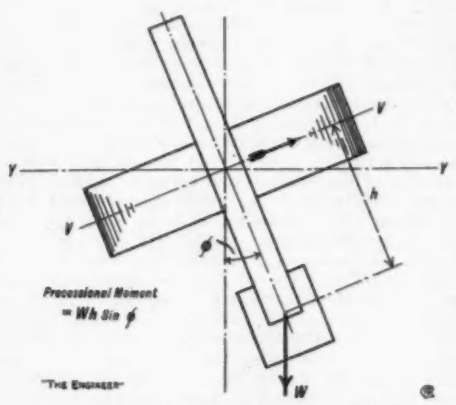


FIG. 27—PRECESSIONAL MOMENT SUPPLIED BY A WEIGHT

precessional axis cannot supply the requisite precessional moment except under one particular set of wave conditions.

It may be noted that if the gyroscope is provided with a fixed weight designed to give complete stabilisation on the standard wave then on the sub-standard wave the weight would be insufficient for its purpose and would fail to bring the gyroscope to rest at the end of the first quarter period—that is to say, in 1·57 sec. At the end of this period the gyroscope would still possess a forward velocity of tilt which would be carried over into the second quarter period. Until that velocity was destroyed the gyroscopic reaction would act, not to oppose the heeling moment, but to assist it to roll the vessel. To meet this contingency Schlick fitted the gyroscope casing with a circular brake, as indicated in Fig. 28, which was adjusted by hand to check the precessional velocity when the wave conditions were such as to require the use of retardation additional to that provided by the fixed counterweight. It was found that during rough weather the equipment required the constant attention of a man to adjust the brake as the waves changed their character. This fact, combined with the considerable amount of power consumed by the equipment, led to the development of the Schlick system being abandoned.

Actually the Schlick system was defective as a means of imparting complete stabilisation from two other points of view, one of which is obvious from our preceding discussion and the other of which cannot be proved without resort to full mathematical analysis. It is clear that the counterweight is required not only to bring the gyroscope to rest at the end of the first quarter period, but to accelerate its recovery of the vertical position during the second quarter period. However satisfactory a brake might be as a means of making good any deficiency of the weight for the purpose of retarding the precession, it would of necessity utterly fail to provide the continued deficiency of the weight as a means of assisting the precession during the recovery of the vertical position. The best that could have been done would have been to release the brake completely during the second and fourth quarter periods so as to leave the weight opportunity to impart unhampered its full but deficient assistance to the precession.

The second respect in which the Schlick system was defective cannot be fully investigated by means of the approximate methods on which we have founded our discussion. It is this: A fixed weight is not only incapable of giving the requisite precessional moment for more than one particular set of wave conditions; it can only give the average value of the requisite precessional moment when the particular set of wave conditions aforesaid arise. In the discussion in the previous article we assumed that the precessional moment required was one which increased or decreased uniformly with time. With a fixed weight, as in the Schlick system, the precessional moment increases or decreases, not uniformly but in accordance with the sine of the angle of tilt. It can be shown that a sine form curve for the precessional moment is no better an approximation to the truth of what is required than our assumed straight line curve. No one fixed weight will serve the end in view; the requirement is a weight which will increase in amount as the tilt of the gyroscope grows and decrease as the tilt falls off. Investigation shows that if the gyroscope is designed to stabilise the vessel by oscillating through 30 deg. on each side of the vertical, the weight should be W at zero time, 1·22 W at T/8, and 1·54 W at T/4, and that it should decrease in the same ratio during the recovery of the vertical position.

We will now employ the approximate formulæ $\alpha=\frac{1}{8}\,C\,r\,g\,T/\dot{\phi}\,I$ and $M_s=8\,C\,r\,I'/\dot{\phi}\,I\,T$ to obtain an estimate of the size and speed of the gyroscope required completely to stabilise a given vessel and to arrive at an idea of the magnitude of the precessional moment which has to be applied to the gyroscope when the vessel is on a train of waves of given magnitude. The quantity C, it may be recalled, is equal to $\frac{\pi}{12}\,\frac{w\,b^2}{d}$, where w is the displacement of the vessel, b her equivalent mean breadth and d her equivalent mean draught. For a typical steamer of 4000 tons displacement we took b at 30ft. and d at 15ft. in article No. VI. Hence for this vessel the quantity C in terms of tons and feet as units has the value 63,000. Let us take it that on the standard wave for which T=6·28 sec. and r=1/20 complete stabilisation is to be given when the gyroscope amplitude is 30 deg. on each side of the vertical. We then have from the first of our approximate expressions:—

$$\frac{\pi}{6}=\frac{1}{6}\times63{,}000\times\frac{1}{20}\times32\times6\cdot28/\dot{\phi}\,I$$

which gives us $\dot{\phi}\,I=201{,}600$ in terms of tons, feet and radians per second. As before, we may take it that the wheel is a plane forged steel disc 2 R ft. in diameter and R/2ft. thick, and that its peripheral speed is to be 600ft. per second, corresponding to a centrifugal tension of 17 tons per square inch. We have already shown that for this disc the quantity $\dot{\phi}\,I$ will be approximately $105\,R^4$. Hence $105\,R^4=201{,}600$ or R=6·62ft. The wheel required will therefore have a diameter of 13ft. 3in. and a thickness of 3ft. 4in. Its weight at 490 lb. per cubic foot will be about 102 tons.

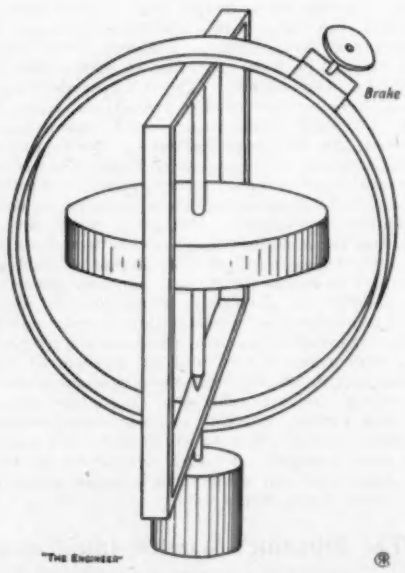


FIG. 28—SCHLICK STABILISING SYSTEM

Its speed $\dot{\phi}$ will be 600/R, or 90·6 radians per second, which is equal to 865 r.p.m. In the following table, column A shows the dimensions of the wheel, as calculated in article No. VI., required to give the vessel complete stabilisation on the standard wave when the precession is continuously in one direction. Column B reproduces the figures just obtained by means of the approximate formula $\alpha=\frac{1}{8}\,C\,r\,g\,T/\dot{\phi}\,I$.

Wheel required.	A Continuously precessing gyroscope.	B Oscillating gyroscope.
Diameter	11ft.	13ft. 3in.
Thickness	2ft. 9in.	3ft. 4in.
Weight, tons	58	102
Speed, r.p.m.	1040	865

The calculation of the precessional moment required necessitates a knowledge of the moment of inertia I'

* No. VIII. appeared May 23rd.

of the complete equipment about the precessional axis. This moment must, if the casing or frame has any weight at all, be in excess of half the polar moment of inertia of the wheel. For the purpose of illustration we will take it that it is equal to the polar moment of the wheel. In practice no assumption need be made for once the size and weight of the wheel have been determined a suitable casing can be designed and from the design the moment of inertia can be calculated. The value so arrived at for the casing would be added to half the polar moment of the wheel to give the moment of the whole equipment about the precessional axis.

According to our approximate formula, the precessional moment required when the gyroscope is at its maximum angle of tilt—in our present example 30 deg.—forward or aft is $M_z = 8\,C\,r\,I'/\dot{\phi}\,I\,T$. For $C = 63{,}000$, $r = 1/20$, $I' = I$, $\dot{\phi} = 865$ r.p.m. $= 90{\cdot}6$ radians per second, and $T = 6{\cdot}28$ secs., this expression gives us $M_z = 44{\cdot}2$ tons-feet. The value of the precessional moment was taken as varying uniformly with time. Accordingly, the moment required at the beginning, middle and end of the first quarter period is as shown in the first line of the table below. In the second line the correct value of the precessional moment required at these three instants as calculated by means of a full mathematical analysis is shown. It will be noted that the difference in the results given by the approximate and the exact methods is slight.

Precessional moment. Time :—	0	T/8	T/4
Approximate	0	22·1	44·2
Exact	0	22·5	40·1

The examination just concluded shows that for the complete stabilisation of our typical 4000-ton vessel a fly-wheel weighing about 100 tons and running at about 870 r.p.m. would be required. On the "standard" wave the gyroscope would oscillate through a range of 30 deg. on each side of the vertical and on waves of greater or less "magnitude"—H T/L—the amplitude would be greater or less than 30 deg. On the assumption made as to the moment of inertia of the gyroscope casing, the precessional moment required to control the equipment on the standard wave would be one varying from zero when the gyroscope axle was vertical to a maximum value of something over 40 tons-feet when the axle was at the limits of its oscillation. The value of the maximum precessional moment would, on waves other than the standard, require to be varied proportionately with the "magnitude"—H/L T—of the waves.

These figures should not be taken as establishing anything in the nature of a criterion of the gyroscopic requirements for the stabilisation of ships. They are based on the dimensions of a hypothetical vessel and are naturally influenced in a prime degree by the estimate made of the heeling moment experienced by the vessel when, in the fully stabilised condition, she is exposed to a train of waves of given dimensions and period. We took that heeling moment as having a maximum value of $w\,b^2\,\pi\,H/12\,d\,L$, where w, b and d are the displacement, equivalent breadth and equivalent draught of the vessel and H and L are the height and length of the waves. Some uncertainty exists as to the dimensions b and d, for they are the breadth and draught of a rectangular block to which the vessel may be considered equivalent. If, in dealing with an actual vessel we know her metacentric height, the uncertainty vanishes, for in place of the terms $b^2/12\,d$ we may use the metacentric height, h, say. The maximum value of the heeling moment then becomes $\pi\,w\,h\,H/L$ and is free from approximation of a doubtful order.

Using this improved means of arriving at the magnitude of the heeling moment we may, for purposes of comparison, calculate the size and speed of the gyroscopic equipment which would be required fully to stabilise the steamship "Corcovado," which was dealt with in Article No. IV. This vessel, on a draught of 22·4ft., had a displacement of 11,600 tons, and with her Frahm tanks empty her metacentric height was 3·35ft. The value of the quantity C, *i.e.*, $\pi\,w\,b^2/12\,d$, or $\pi\,w\,h$, comes out at 122,000. From the approximate formula $\alpha = \frac{1}{8}\,C\,r\,g\,T/\dot{\phi}\,I$, taking α as before at 30 deg., r at 1/20 and T at 6·28 sec., we get $\dot{\phi}\,I$ as being 390,400. Assuming, as previously, that the gyroscope wheel has a thickness equal to half its radius and that the centrifugal tension in its periphery is to be 17 tons per square inch, we get the following figures for the wheel :—

Gyroscopic Stabiliser for "Corcovado."

Diameter of wheel	15ft. 7½in.
Thickness	3ft. 10in.
Weight	166·5 tons
Speed	735 r.p.m.

To the weight of the wheel we must add a fairly considerable figure for the casing, the casing support, and the driving and other equipment in order to obtain the total weight involved in the stabilising apparatus. This additional weight is determined by questions of design and to some extent by the precise means to be adopted for applying the controlling or precessional moment to the gyroscope. It is probable that an allowance for these additional weights equal to the weight of the wheel itself would not be an excessive estimate. It may, therefore, be calculated that the probable weight of the complete stabilising equipment would be in the neighbourhood of 330 tons, or about 2·8 per cent. of the vessel's displacement. It may be recalled that the weight of water in the Frahm tanks with which the "Corcovado" was actually fitted amounted to 188 tons, and that allowing for the structural weight of the tanks themselves, we estimated the total additional weight involved in stabilising the vessel on the Frahm system at about 200 tons. The gyroscopic system, it can therefore safely be said, involves a greater addition to the displacement of a vessel than does the anti-rolling tank system. The comparison is not, however, strictly just. The Frahm system does not and cannot give complete stabilisation to the vessel. It reduces the rolling to a small amount, but does not wholly eliminate it. Our estimate for the weight of the gyroscopic equipment required is based on the assumption that the vessel is to be completely stabilised. If we are content with partial stabilisation on the gyroscopic system, of the same order as that realised with the Frahm system, a very material saving in the weight of the equipment required can be realised.

Mathematical Note.—The exact manner in which the precessional moment is required to vary as the oscillation proceeds can be determined from equations (6) and (8) of the note appended to article No. VII. These equations are :—

$$\mathrm{Sin}\,\varphi = \frac{n}{B}\sin B\,t \quad . \quad . \quad . \quad . \quad (6)$$

$$\ddot{\varphi} = \frac{n\,B^2\,(n^2 - B^2)\sin B\,t}{(B^2 - n^2\sin^2 B\,t)^{3/2}} \quad . \quad . \quad . \quad . \quad (8)$$

where $n = K\,g/\dot{\phi}\,I$ and $B = 2\,\pi/T$.

If the angular acceleration $\ddot{\varphi}$ is supplied by a weight W at a distance h below the precessional axis—as in Fig. 27—then $\ddot{\varphi} = W\,h\sin\varphi \cdot g/I'$, where I' is, as in the text, the moment of inertia of the wheel, casing, &c.—including the weight W itself—about the precessional axis. Substituting for $\sin\varphi$ from (6), and equating to (8), we get—

$$W\,h = \frac{B^2\,I'\,(n^2 - B^2)}{g\,(B^2 - n^2\sin^2 B\,t)^{3/2}}$$

It is evident, therefore that either W or h must be a function of the time t. If the maximum value of φ is 30 deg., then $n/B = \frac{1}{2}$, from (6). In this case

$$W\,h = \frac{24\,n^2\,I'.}{g\,(4 - \sin^2 B\,t)^{3/2}}$$

We therefore have—

At time $t = 0$, $W\,h = 3\,n^2\,I'/g = J$

At time $t = T/8$, $W\,h = 3{\cdot}66\,n^2\,I'/g = 1{\cdot}22\,J$

At time $t = T/4$, $W\,h = 4{\cdot}62\,n^2\,I'/g = 1{\cdot}54\,J$.

(To be continued.)

Flowing Water.

By J. M. LACEY, M. Inst. C.E.

No. II.*

RIVERS may be divided into two classes, those fed by flat or slightly hilly basins, generally in permeable ground; and secondly, those rising in mountainous and impermeable ground. Rivers draining large extents of country may contain in their hydrographical basins areas characteristic, in a varying degree, of both the above classes. Before proceeding to lay down any "project" in connection with a river a general survey must be made or obtained of the main stream and of all its affluents. The survey should indicate the physical features and geological character of the river basin under consideration, together with the extent of cultivated and fallow land and of wooded areas in its catchment. Careful observations must be made upon the height of the lowest waters, the mean and the flood stream, taking care that they be averaged over the greatest possible number of years. Where possible, the volume of flow must be gauged in all the above stages. Thus, in short, it will be necessary to collect and tabulate gaugings of the highest, lowest and mean flows of the river; to note particularly readings both of exceptional floods and low water; and in all cases in which the observations have been sufficiently numerous to deduce the laws governing the amount of flow. The nature of the matter held in suspension, the tendency of the river to scour or to deposit, and the nature of the bed are also points of vital importance. For construction purposes the capabilities of the surrounding country for the provision of the necessary materials will require to be investigated.

The "external spills," or overflowing of the flood water in some rivers produces the following results, viz., that the zones in the immediate proximity to the river margins are generally more elevated than those which are farther removed. This is to be accounted for by the fact that the great floods deposit, near to their banks, the heaviest and most voluminous matter they hold in suspension, and that they are far less loaded as they spread out over the plain. From this cause marshes are eventually formed. Floods are charged with the maximum amount of foreign matter they are able to hold in suspension, when their intensity diminishes, or the speed of the current is slackened, the waters deposit gradually and in order of their specific gravities the substances they contain. A different relation is thus established between the section of the river, the volume of the water, the form of the outline of the bed, the fall of the river, and the velocity of the current. Towards the downstream portion of the river, the section will be found to have become less able to carry off another flood, and if the sides resist erosion less than the bed, the river will spread out, often into several branches, with diminished depths. A similar phenomenon is observed in rivers debouching from the Himalayas into the plains below. Owing to their steep fall, often 40ft. to 50ft. per mile, the rivers bring down an enormous amount of *débris*, consisting of boulders, shingle, sand and clay, which is spread fanwise over the country, the apex being at the point of debouchment. The main river usually occupies a depression in the highest ridge of the fan, draining the mountain valley above it; smaller streams between the fans drain the spill water from the main river and the local rainfall. It sometimes happens that after a very high flood, when the volume and velocity of the river is moderated, a large quantity of *débris* is deposited in the main river channel and the river is diverted from its original channel in a single day. In the lower portions of a river where it falls into the sea, other causes also operate, resulting in the formation of deltas, and the river enters the sea through numerous channels. As the deltas proceed seawards there is a natural tendency for river beds to be raised.

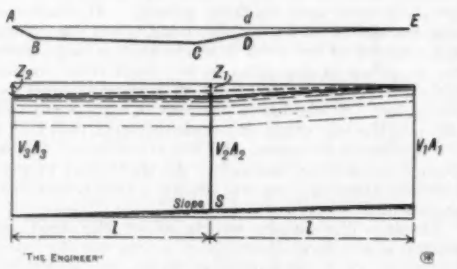
Floods.—The causes which affect the rate and volume of the flood discharge of a river are the extent and shape of its hydrographic basin, the length and slope of its main stream to the point of discharge, the direction and intensity of the prevalent rainfall on the river basin. The character of the basin and its vegetation are factors which also influence the flood discharge. It is seldom that an engineer has an opportunity of seeing the highest flood of a river; even if he should happen to witness one, he may not possess at the time the necessary means of measuring the section and the volume. He therefore has of a necessity to gather the necessary data from flood marks and observations of others. Notwithstanding the most careful investigations and inquiry as to the maximum discharge of rivers and heights reached in a country lacking a systematic series of observation of such data, and even in countries where such systematic observations exist, it happens that floods occur, reaching greater heights and larger volumes than were remembered by the oldest inhabitants. This tendency to more frequent and greater volumes of floods may be attributed to larger built-up areas, making of impermeable roads and other ways, the ditches and drains of which deliver the water more rapidly than heretofore, and to the clearing of streams and drainage channels which prevent the local accumulation of water. The heights to which the flood water rises are due to the numerous obstructions, such as embankments, bridges and weirs, which affect the natural beds of rivers.

To estimate the probable maximum flood discharge at a point of a river there are various formulæ extant by means of which an approximation may be made from a consideration of the character of the river basin, the variation and intensity of the rainfall and direction of the prevalent storms. The methods by which such estimates of the maximum flood discharges of a river are made are discussed in full in Papers Nos. 4452, 4473 and 4489, "Proc.," Inst. of Civil Engineers, Vol. CCXVII.

Where flood marks exist a method commonly adopted is to select a reach where the river is straight and of a tolerably uniform section; to ascertain by means of levelling an accurate cross section of the river at the gauging site contained between the highest flood line and the river bed. The same procedure to be adopted at points above and below the gauging site and at equal distances from it. From the profiles so obtained the hydraulic mean radius and the wetted perimeter at each of the sections can be obtained. In most large rivers when in flood, the hydraulic mean radius will differ very slightly from the mean depth, and the wetted perimeter from the width of the river at its surface. From the flood marks it may be possible to obtain the surface fall of the river when in flood, and from the data so obtained the mean velocity and volume of discharge can be calculated from known formulæ. The difficulty arises in ascertaining the true surface slope at the gauging site. Very often the fall of the mean bed level between the upper and lower cross section is assumed to be the slope at the gauging site. Colonel Abbott, in 1852, in his instructions for gauging the maximum floods of rivers, fixed the positions of the upper and lower sections at one mile above and one mile below the central section. The bed fall in the two miles in inches multiplied by the mean of the hydraulic mean radii of the three sections also in inches, and the square root of the product so obtained, Colonel Abbott states, will be the surface velocity which, multiplied by 9/10, gives the mean velocity of the river in inches in the reach under consideration. Converted into feet and multiplied into the mean of the three cross sectional areas, he states, gives the discharge of the river. He gives as example: If the hydraulic mean radii are 6·8ft., 6·48ft. and 6·1ft., the mean $= 6{\cdot}46$ft. $= 77{\cdot}52$in. If the difference in bed level between the upper and lower section is 30in., the surface velocity $= \sqrt{77{\cdot}52 \times 30} = 48{\cdot}2$in. per second, which, multiplied by $9/10 = 43{\cdot}38$in., or 3·6ft. per second, the mean velocity of the reach. This velocity multiplied into the mean of the three sectional areas gives the volume of water passing down the

* No. I. appeared May 23rd.

river in cubic feet per second. Colonel Abbott, however, points out that in a cross section of a river, as denoted by Fig. 10, a section not uncommon in Indian rivers when in flood,* there will be a considerable difference in the estimated velocity according as the hydraulic mean radius is calculated for the whole cross section, or if the cross section is divided into two parts A B C D and the triangle D *d* E and the velocity for each part estimated separately (*vide* "Memoirs to Military Science," 1852). Colonel Abbott's instructions can only be considered as an approximation; their merit lies in their simplicity. It is obvious that unless the reach under consideration is of more or less uniform section, the surface slope will not correspond to the bed slope—*vide* Fig. 11. Neglecting the roughness of the channel and assuming that the square of the mean velocity of the sectional area represents the energy of the flowing water,



FIGS 10 AND 11

$$Z_1 = \frac{V_2^2 - V_1^2}{2g} + s\,l$$

Therefore, unless the sectional areas A_1 A_2 and A_3 are equal and similar in shape and character, the surface slopes may vary considerably in the reach. Also levels and measurement to obtain the sectional areas and fall of the bed can normally only be taken at low water; no account, therefore, is taken of the tendency of a river to deepen and scour its bed during floods. Fig. 12 shows the variations in water levels and bed levels of the river Indus for the year 1914. The bed levels are the mean depths below datum—*vide* "Flowing Water," Part I., May 23rd.

Reliable results can only be obtained by gauging the river. This may prove a difficult matter when a river is in flood, and recourse may have to be made to the use of surface floats. Surface floats are used to ascertain the velocity of flow, particularly when a river is in flood, when it is difficult to gauge the river in any other way, owing to the fact that a boat cannot be accurately manipulated, and when it is a difficult matter to obtain accurate soundings, so that more accurate methods of gauging are not worth the time and trouble spent on them. That is, in short, gauging by surface floats is useful for approximate results when more accurate methods are not possible, or are not required. It merits in being simple and rapid, and when checked by more accurate methods is useful. Mr. Edgar C. Thrupp states:—"The relation between the mean velocity and the maximum surface velocity in open channels has always been attractive, as being a simple factor to be used in gauging, but the accuracy obtained depends upon a knowledge of the correct ratio to apply in any particular case"—"Proc.," Inst. Civil Eng., CLXXI., page 343. Mr. Neville gives the following rule:—If $V_{s\,max}$ is the maximum surface velocity, and V_m the mean velocity of the transverse section of the stream at right angles to the direction of flow,

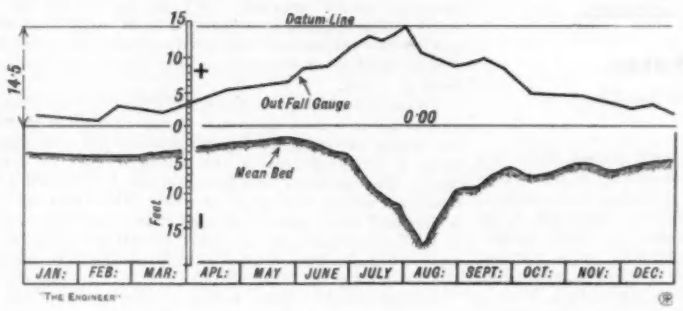


FIG. 12

$$V_m = \frac{7{\cdot}783 + V_{s\,max}}{10{\cdot}345 + V_{s\,max}} \times V_{s\,max}$$

Professor Wagner, from numerous observations on the Weser, the Elbe, the Rhine, the Danube, and the Mississippi rivers, arrives at the following results:—For a fairly regular section with no marked irregularities,

$$V_m = 0{\cdot}705\,V_{s\,max} - 0{\cdot}01\,V_s^2{}_{max}$$

Also, if $V_{s\,c}$ is the central surface velocity of the river,

$$V_m = 0{\cdot}738\,V_{s\,c} + 0{\cdot}05\,V_s^2{}_c$$

In the case of vertical velocities in a stream or river, if v_s is the surface velocity in any vertical section of a river or stream, and v_m the mean velocity thread in that section,

$$v_m = 0{\cdot}738\,v_s + 0{\cdot}05\,v_s^2$$

Professor Wagner states that the mean velocity thread in a vertical section is situated at 0·597 of the depth. The maximum velocity in the vertical in sixty-four cases varied in position, from the surface at the river Weser, to 0·25 of the depth in the Rhine. The bottom velocity, he considered, must be zero and rising rapidly—"Proc.," Inst. C.E., Vol. LXXI. Harlacher states that no very constant ratio exists either between V_m and $V_{s\,max}$ and the mean of the surface velocities. He states that in any vertical, if v_s is the surface velocity, the discharge of the stream is a coefficient p multiplied by the sum of ($v_s \times$ the corresponding vertical strip of the cross section). Or if l be the length of the water surface of the transverse section at right angles to the direction of flow and v_s the surface velocity and d the depth at any point on l. The discharge, according to Harlacher, will be

$$Q = p \times \Sigma\,(v_s\,d \times d\,l),$$

or $p \times$ the area of the curve represented by $v_s\,d$ on the base l. In 28 gaugings on the Danube and Bohemian rivers with widths ranging from 160ft. to 1400ft., and maximum velocities varying from 2ft. to 10ft. per second, and depths from 2·5ft. to 25ft., he found p to vary between 0·79 to 0·91, and lay between 0·83 and 0·88 in twenty-three cases. Harlacher also states that p is greatest for sandy beds, and its minimum value occurred with beds of gravel of the size of a man's fist. In Switzerland, for 200 cases, the mean value was 0·835, the smaller figure being due possibly to the mountain streams possessing gravelly and stony beds. For the Rhine in Holland, he found the value of p to be 0·87 owing to the fine quality of the sand—"Proc.," Inst. C.E., XCI. Mr. Thrupp, in this connection, states that experimental results have been published giving values between V_m and $V_{s\,max}$ varying between 0·47 and 0·95; but no formula or table has been published which reconciles the discrepancy between various observations which ensures results correct to within 10 per cent. He considers that the ratio $\frac{V_m}{V_{s\,max}}$ depends on the shape of the channel, and arrives at a factor representing shape—"Proc.," Inst. C.E., Vol. CLXXI.

The report of the Indus River Commission states that in the Indus River the maximum velocity in a vertical is at the surface, the average of 4199 observation show the ratio of the mean velocity thread in a vertical to the surface velocity in that vertical to be 0·851, or

$$\frac{v_m}{v_s} = 0{\cdot}851$$

The report also states that this ratio does not increase proportionately with increase in depth, but remains more or less constant. The bottom velocities in any vertical could not be obtained by observation, as it was not possible to operate the meter close to the bottom. An analysis, however, of the vertical velocities curves given in the report of the Indus River Commission shows that the ratio $\frac{v_m}{v_s}$ in any vertical depends on the form of the vertical velocity curve; that is, on the ratio of the surface velocity to that at 9/10 depth. Velocities at greater depths have not been taken for reasons given above. Table III. compares the ratio of $\frac{v_m}{v_s}$ to that of $\frac{v_s}{v_{9/10}}$. v_m is calculated by obtaining the area of the vertical velocity curve by Simpson's rule, assuming in all cases that the bottom velocity is zero (for the sake of uniformity), and dividing the area so found by the corresponding depth. Fig. 13 shows the curve of vertical velocities for October 10th, 1914, depths 8ft. and 9ft., and that of March 27th, 1918, at Sukkur; Fig. 14 shows vertical velocities curves for March 3rd, 1914, and September 25th, 1917, at Kotri. The analysis indicates that the ratio $\frac{v_m}{v_s}$ in any vertical depends on the condition of flow, whether turbulent or approaching streamline motion; in short, on the degree of turbulent motion. This degree of turbulent motion depends largely on the amount of silt carried in suspension, appertaining to the existing hydraulic conditions of flow, which tends to damp the eddies of turbulent motion.

TABLE III.—*Sukkur.*

$v_s/v_{9/10}$	v_m/v_s	$v_s/v_{9/10}$	v_m/v_s	$v_s/v_{9/10}$	v_m/v_s
5·36 } *	0·67	1·73	0·78	1·353	0·823
2·214 }	0·707	1·548	0·767	1·352	0·839
2·23[1]	0·75	1·514	0·851	1·32	0·824
1·976	0·78	1·5177	0·775	1·271	0·865
1·95	0·753	1·5	0·77	1·258	0·86
1·967	0·847	1·47	0·828	1·25	0·86
1·88	0·763	1·46	0·8115	1·191	0·874
1·77	0·765	1·345	0·8375	1·133	0·903
				1·0376[2]	0·9202

* October 10th, 1914, minimum velocity at 9/10 depth observed at Sukkur.
[1] Minimum silt, January 7th, 1914, at Sukkur.
[2] Maximum silt observed at Sukkur (1911 to 1920) on March 27th, 1918.

Kotri.

$v_s/v_{9/10}$	v_m/v_s	$v_s/v_{9/10}$	v_m/v_s	$v_s/v_{9/10}$	v_m/v_s
12·8[3]	0·49	1·70	0·776	1·27	0·81
1·9	0·8	1·43	0·806	1·26	0·848
1·847	0·777	1·34	0·855	1·232	0·845
1·823	0·747	1·323	0·848	1·177	0·818
1·76	0·788	1·31	0·82	1·056	0·9[4]

[3] Minimum velocity at 9/10 depth March 3rd, 1914, at Kotri.
[4] Maximum silt observed at Kotri, September 25th, 1917.

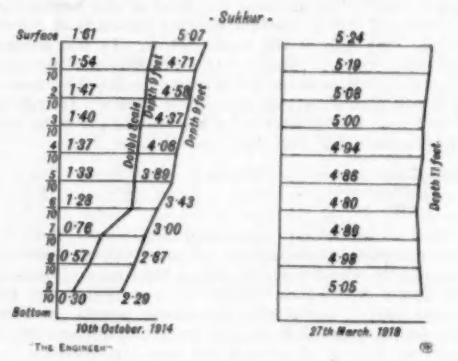


FIG. 13

velocity at any point taken parallel to the axis of the current, and is the only velocity of much use in practical hydraulics. The motion of streams being unsteady, it is obvious that the forward velocity at a point cannot be obtained by one observation, and its mean is obtained by averaging a number of momentary values. The actual gauging of a stream or river is carried out by means of (1) current meters, (2) Pitot tubes, (3) rod floats, (4) chemical means. Gauging by current meter is applicable to all streams, and is the only possible method in large rivers, except perhaps gauging by chemical means. Rod floats are specially adapted for regular canals. Pitot tubes are useful for ascertaining the velocity at a point and are more advantageously used in measuring the discharge of pipes than that of large open streams. For gauging by chemical means attention is drawn to a paper by Mr. C. E. Stromeyer, printed in the "Proceedings" of the Institution of Civil Engineers, Vol. CLX, page 349.

Although in detail the motion of streams is unsteady, yet there is an average steady motion, and the unsteady motion can be allowed for in the case of a current meter by allowing it to run for some time, and in the case of "rod floats" by repeated measurements. It is usual to run the current meter from one to three minutes to obtain the velocity at a point; and in the case of rod floats to obtain uniformity for all practical purposes the mean of the velocity of five runs is assumed to be sufficient. Major Allan Cunningham considered that in the case of rod floats uniformity could be obtained by repeated measurements, and gave forty-eight runs for each float as the standard to be aimed at—a counsel of perfection.

Current meters are of two types, one being of the screw type with wheels made up of flat or warped surface vanes, set on a horizontal axis. In this type the friction increases as the velocity decreases. It is a direct-action meter. The other is of the anemometer

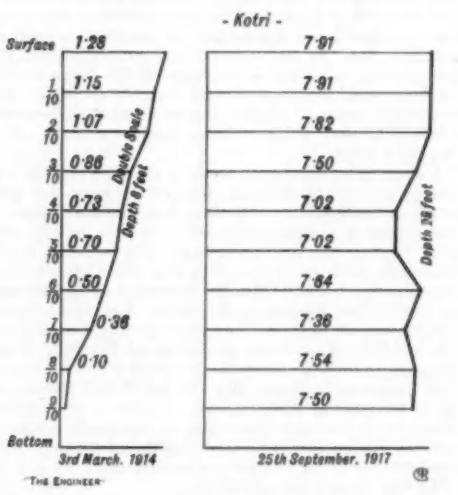


FIG. 14

* *Vide* pages 71, 73 and 74, "Proc.," Inst. Civil Engineers, Vol. CXXXIV.

NEW COKE OVENS OF THORNCLIFFE COAL DISTRIBUTION, LTD.

THE WOODALL-DUCKHAM COMPANY, WESTMINSTER, ENGINEERS

FIG. 1—OVEN TOP, COAL CHARGING CAR AND COAL BIN

type, consisting of a series of cups revolving on a vertical axis; in this type the friction increases with the velocity, but increased frictional effect is overcome by increased motive power due to the velocity. They are differential meters. There are also specially designed meters for small depths and low velocities. From a series of experiments made in the United States of America to test the accuracy of gauging by current meters it was found that the meter discharge in any case never differed from the corresponding weir discharge by as much as 5 per cent. Also the difference between corresponding meter discharges was never greater than this. If the mean differences are taken the amounts are reduced to about 1 per cent. Errors are due to calibration of the meter; irregularity in the motion of the water; irregularities in the bed of the stream and errors in sounding; and the difficulty in obtaining accurate results when a river is in flood.

In the case of "rod floats" it is assumed that the pressure exerted by the particles of water on the rod is proportional to the relative velocity. Major Allan Cunningham found that the exact length of rod to give the true mean velocity in a vertical depended on the position of the maximum velocity in the vertical velocity curve; he found the length to vary between 0·97 D to 0·91 D, where D was the total vertical depth at the point. From observations on the Upper Rhine it was observed that the maximum velocity in a vertical occurred at the surface of the water, provided the depth did not exceed 18ft.; for greater depths the maximum velocity occurred below the surface; for depths varying between 8ft. to 20ft., measured vertically, the length of the rod should be 0·944 D to 0·940 D. When from the presence of weeds, boulders and irregularities in the bed it is not possible to use a rod float of the correct length, Mr. Francis gives the following formula:—

$$v_m = v_r\,(1 - 0{\cdot}116\,(\sqrt{d} - 0{\cdot}1),$$

where v_m is the mean velocity of the vertical velocity curve, v_r is the velocity as ascertained by a rod float, d is the difference between the total vertical depth and the rod float divided by the total vertical depth.

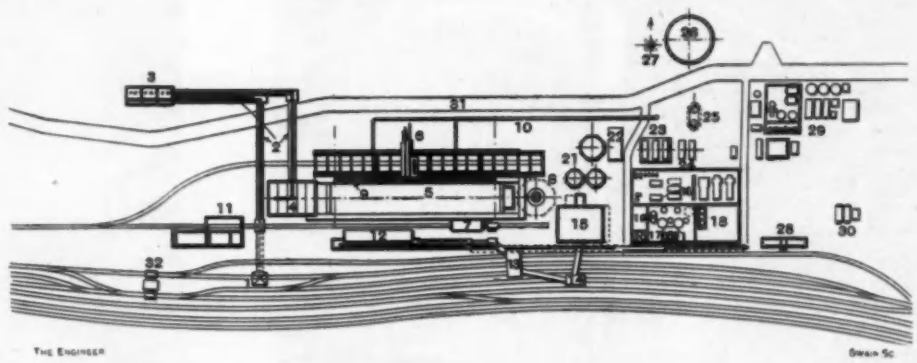
AT the recent general meeting of the members of the Royal Institution it was announced that the Managers had received and accepted from the Trustees of the Rockefeller Foundation an offer of a donation of £20,000 for endowment of research in the Davy Faraday Laboratory, on condition that the sum of £50,000 for the same purpose should be secured by the Royal Institution from other sources before June 30th, 1933; with an additional payment of £1000 per annum up to a total of £3000 for maintenance of research in the laboratory until such time as the capital payment should be made.

New Coke Ovens near Sheffield.

A FEW days ago we sat taking tea *al fresco* at Smithywood, near Sheffield, with one of the biggest banks of coke ovens on one side and great banks of bluebells on the other. They were not a hundred yards apart. Those coke ovens, of which we give a number of illustrations, have been supplied to Thorncliffe Coal Distillation, Ltd., by the Woodall-Duckham Company, of Allington House, Victoria-street, Westminster, and have now been in operation for some eighteen months. They have, consequently, got well down to their work, for the process of starting a coke oven is slow, and can safely be said to have proved a success. The plant is capable of carbonising 1200 tons of coal a day and produces each week 97 tons of ammonia sulphate, 5800 tons of coke, 68,000 gallons of tar, and 29,600 gallons of crude benzol. Surplus gas to the extent of some 26 million cubic feet is sold to the Sheffield Gas Company, being sent away in a high-pressure main, and even then about 4 million cubic feet have to be burned to waste at the "bleeder," as there is no immediate market for it. The primary object of the plant is, of course, the supply of metallurgical coke to the company's blast-furnaces at Thorncliffe. That such a great industrial works defaces the countryside so little is a testimonial to the effectiveness of the efforts of the company to avoid nuisance and to conserve to the utmost all the useful constituents of the coal. It is also noteworthy that it is the boast of the company that not even waste water is allowed to leave the works.

The battery consists of fifty-nine Becker regenerative ovens, normally heated with coke oven gas. The design, however, permits of operation with clean producer gas, after minor exterior changes of gas piping connections, &c., have been made. The ovens are 40ft. 8in. long from face to face of the doors, 12ft. 6in. high, and the mean width is 16in. The coal capacity per oven is approximately 15 tons of wet coal or 13·50 tons of dry coal. With the exception of the regenerator bottom liners and fillings and the end walls adjacent to the reinforced concrete pinion walls, the remainder of the oven brickwork, from the pad upwards, is constructed of silica. The oven tops are insulated and are capped with paving bricks. The oven jambs and regenerator facings are also insulated. Concrete retaining walls, some 4ft. thick, provided with wing walls, are constructed at each end of the battery. A fire-brick-lined concrete waste gas flue is built on each side of the battery. The oven stack is 250ft. high and is fire-brick lined for the first 50ft.

Washed coal is received from three points by aerial ropeway and is delivered to three hoppers. From thence it is discharged through revolving plate feeders—see Fig. 13, page 604—on to a belt conveyor, and so to the oven coal bin. A rotary tippler and a track hopper are also provided.



1.—Track Hopper for Coal.
2.—Coal Conveyors.
3.—Coal Reception Hoppers.
4.—Coal Storage Bin.
5.—Battery.
6.—Pusher Machine.
7.—Coke Car.
8.—Stack.
9.—Collecting Main.
10.—Suction Main.
11.—Quenching Station.
12.—Coke Wharf.
13.—Primary Coke Screening Station.
14.—Secondary Coke Screening Station.
15.—Boiler-house.
16.—Power-house.
17.—By-product House.
18.—Sulphate Store.
19.—Lime Mixing Room.
20.—Lime Store.
21.—Tar and Ammonia Storage Tanks.
22.—Liquor Flushing and Separating Tank.
23.—Primary Coolers.
24.—Final Coolers.
25.—Benzol Scrubbers.
26.—Gasholder.
27.—Bleeder.
28.—Waste Liquor Settling Basins.
29.—Benzol Plant.
30.—Acid Storage Tanks.
31.—Roadway.
32.—Weighbridges.

FIG. 2—PLAN OF COKE OVEN AND BY-PRODUCT RECLAMATION PLANT

NEW COKE OVEN PLANT OF THORNCLIFFE COAL DISTRIBUTION, LTD.

THE WOODALL-DUCKHAM COMPANY, WESTMINSTER, ENGINEERS

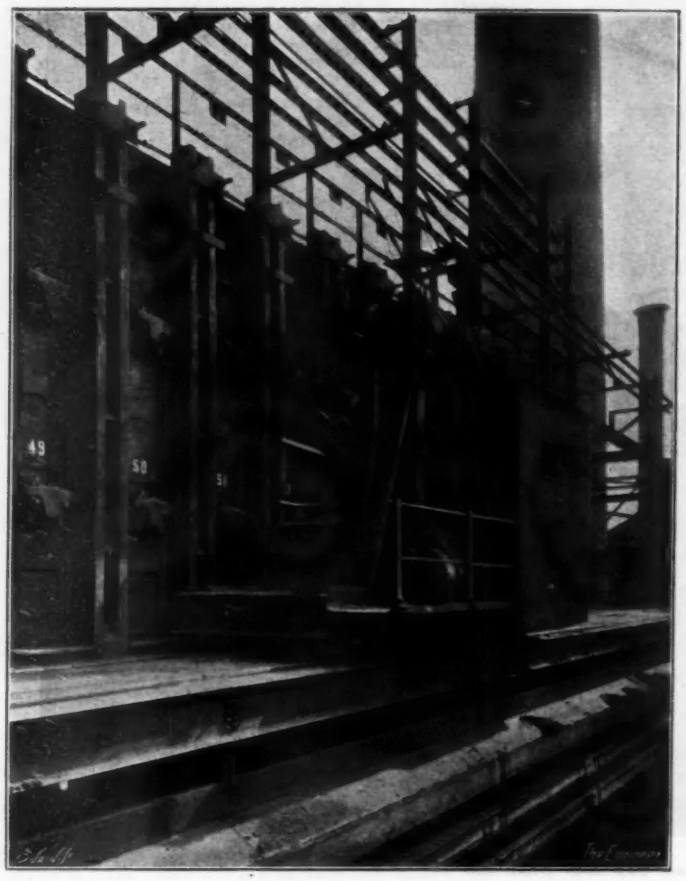


FIG. 3—DOOR LIFTING MACHINE

FIG. 4—AIR AND WASTE GAS REVERSING VALVES

FIG. 5—SATURATOR AND ACID SEPARATOR

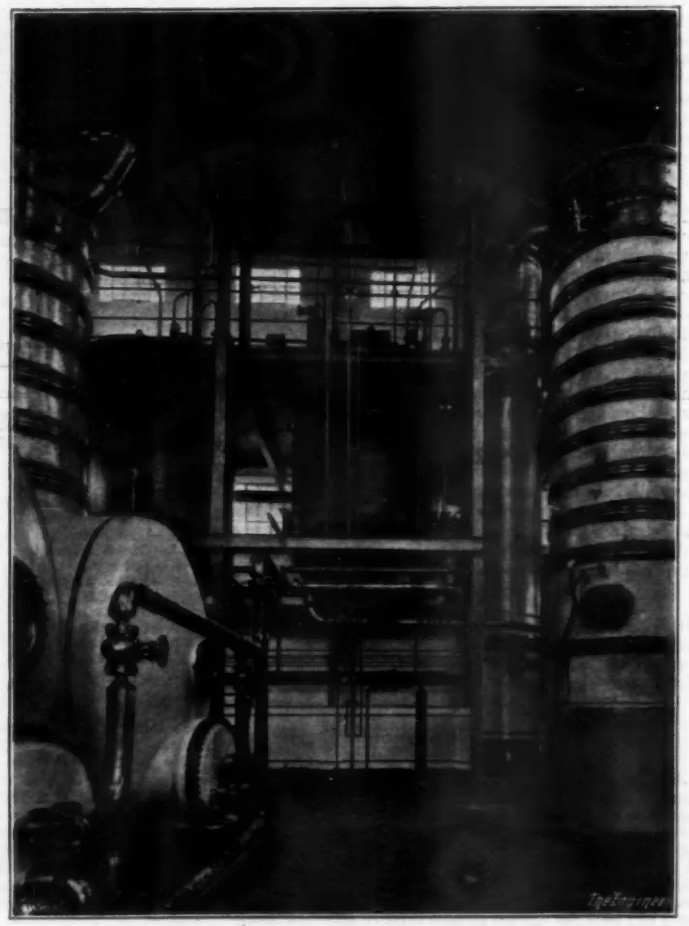


FIG. 6—BENZOL RECOVERY AND RECTIFICATION PLANT

They allow of receiving coal in railway wagons. A second belt conveying system connects the track hopper with the three hoppers normally fed by the aerial ropeway.

The coal for the ovens is stored in a reinforced concrete bin with a storage capacity of 2500 tons. It is built in five bays with four hoppers per bay. One bay, containing 500 tons, is entirely separate and may be used for experimental purposes. The oven top and coal bin are shown in Fig 1.

For charging the ovens there is a coal charging car—see Fig. 1—consisting of four steel hoppers with a total capacity of approximately 15 tons, which is mounted on

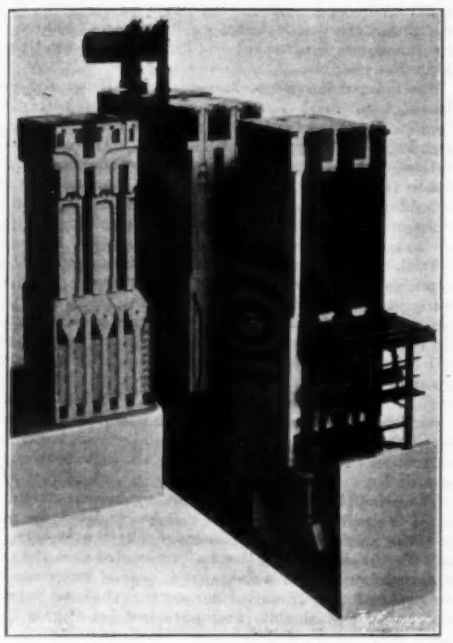


FIG. 7—SECTIONAL VIEW OF BECKER OVEN

a trolley that runs along the top of the battery. Each hopper has an adjustable measuring device and a cast iron drop sleeve for directing the coal into the ovens. These sleeves are operated by a lever, interlocked with the traction motor, and make it impossible to move the car with the sleeves down. Four charging holes in each oven correspond with the drop sleeves. The charging car is driven by an alternating-current motor.

The coke oven gas passes from the ovens through ascension pipes into steel gas collecting mains. Flushing sprays are installed in each ascension pipe and in the collecting main at alternate ovens. Two liquor-flushing pumps are provided, one acting as a spare. Each has a capacity of 50,000 gallons per hour. A Shallcross governor controls a butterfly valve in the offtake mains and accurately regulates the pressure in the gas collecting main. This device was described in our issue of August 17th, 1928.

The basic feature of the Becker coke oven is the cross-over flue, which can be seen in Fig. 7. This arrangement makes it possible to employ horizontal flues of small dimensions in spite of the big volumes of gas to be handled, thus ensuring great strength of the battery structure, even heat distribution at every point on the oven wall and high thermal efficiency. The flow of the heating gases may briefly be described as follows. There is a series of vertical flues on each side of each oven. Two regenerators are built under each series of vertical flues. Air travels up the regenerators and meets with gas at the base of the vertical combustion flues, up which the gases travel in parallel. The products of combustion are collected from each four or five vertical flues, and are carried over the top of the ovens by means of cross-over flues. There are six cross-over flues to each alternate oven. The intermediate ovens have no cross-over flues. From the cross-over flues the waste gases are distributed into vertical flues exactly opposite the flues up which they have travelled on the other side of the oven. They travel down the vertical flues and are equally distributed in the two regenerators below. This arrangement of heating ensures that the travel of gases is short and the speed slow, so that good regulation can be obtained with a low difference of pressure. The heating gases in all the vertical flues on one side of an oven always travel in parallel flow and there is no possibility of short circuiting and consequent loss of efficiency. The volume of gas burnt in each vertical flue is so graduated that more heat is supplied at the wider end of the oven in order to ensure even carbonisation throughout the charge.

The coke oven gas, which is the fuel normally used for heating the ovens, passes through a steel main to the combustion flues. The volume of fuel gas used by the ovens is recorded and integrated by a Kent's Venturi type meter. There are 240 reversing valves, arranged 120 on each side of the battery, for the controlling and reversing of air and waste gases in the regenerators. Fig. 4 shows some of these automatically-operated valves. They are opened and closed alternately in groups of four and are situated in a spacious covered alleyway. Reversing is automatically effected every thirty minutes by a single machine—see Fig. 8—which is connected to the individual gas cock levers and reversing valves. It will be noted that the important moving parts are totally enclosed, the machine being placed in the control room at the end of the battery. The machine is normally operated by an electric motor, but a steam-operated standby is provided, which can be used in case of failure of the power supply.

The movements of the machine are controlled by an electric clock, which can be seen in the illustration. The clock can be set to operate the reversing mechanism at various intervals. Should for any reason the clock fail to operate the mechanism at the predetermined time, within one minute the water safety device, seen in the right-hand corner of the room, causes a steam siren to blow.

When the charge of coal is carbonised the coke is pushed out of the retort, endways, by means of a pusher machine into a coke quenching car. This machine, which is by the Wellman Smith Owen Engineering Corporation, is of orthodox design, carries a ram built up of structural steel with a cast steel head. In addition to the ram, it carries a rope-driven leveller bar to level the top of the coal in the ovens, and a door ram to remove the doors in preparation for the pushing operation. A very similar machine was described in our issue of August 17th, 1928.

The pusher ram pushes the coke into a coke quenching car which has a capacity of approximately 11 tons. The bottom of the car is constructed of sloping cast iron plates. It has four side gates of ribbed cast steel, operated by air cylinders and is driven by an electric locomotive.

A special door lifting machine runs along a track on the discharge side of the bench and removes the doors on this side. This machine is shown in Fig. 3. Fig. 9 shows the oven doors, with their latches, and the side buckstays. On the same side a coke guide, which runs on rails, directs the coke into the coke quenching car as it is pushed from

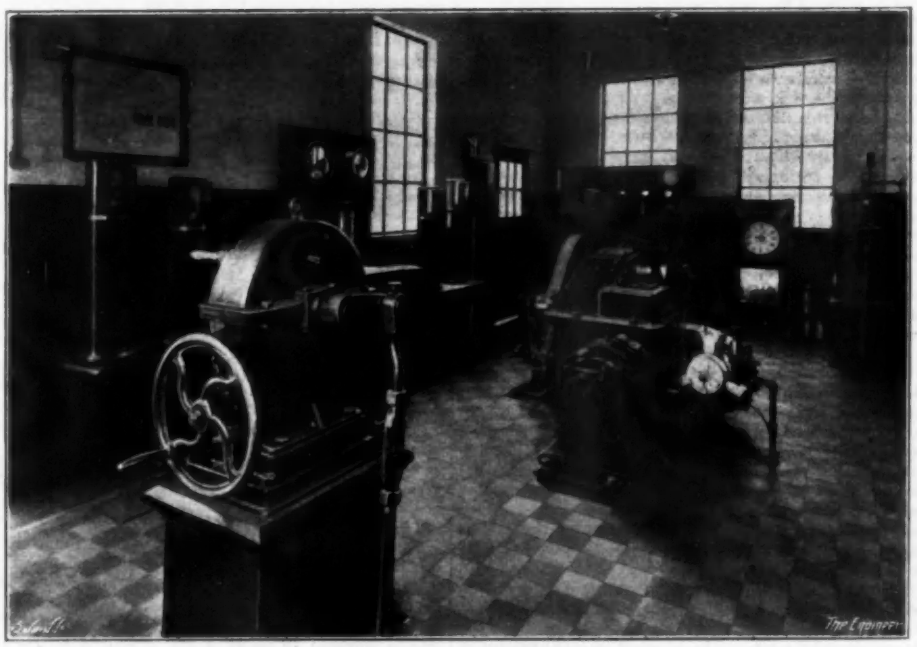


FIG. 8—REVERSING MACHINE AND CONTROL ROOM

the ovens. The coke quenching car with its content of red-hot coke is run under the brick tower of the central quenching station. It is then sprayed with a predetermined quantity of water. A 10,000-gallon quenching tank feeds the sprays through 16in. diameter piping. Two quenching water pumps are provided. Each has a capacity of 33,000 gallons per hour. One pump acts as standby to the other. The pumps are automatically operated by a float control in the overhead quenching tank. A breeze settling sump is provided beneath the tower to clear the water of entrained coke dust and breeze. After quenching the coke is conveyed to the inclined coke wharf, where it is spread out and is finally cooled before being delivered to the screening plant.

Coke from the inclined wharf is fed through finger gates to a belt conveyor and is delivered to a 2½in. rotary grizzly screen. The oversize is delivered on to a boom conveyor and passed direct into trucks. The undersize is transferred to a 1¼in. Gyrex screen, the oversize again being loaded—by boom conveyor—into trucks. The undersize goes on to the secondary screening station, where a 1in. rotary screen and a ¼in. Hummer screen finally grade the coke. The three sizes so produced, *i.e.*, 1¼in.–1in., 1in.–¼in. and ¼in.–0, are stored in three separate bins. From thence the breeze is conveyed to the boiler-house by means of a belt conveyor system, and the other two sizes are discharged into railway wagons below. This part of the plant was supplied by the Fraser and Chalmers works of the General Electric Company, Ltd.

The ammonium sulphate recovery plant and the power plant, *i.e.*, exhausters, boosters, generating sets, &c., are housed in a building 140ft. long, 95ft. wide, and about 30ft. high. The building is divided into two sections, one the power-house, the other the by-product house.

The process of ammonia recovery employed at Thorncliffe is termed the "semi-direct" process and may briefly be described as follows.

The gas is drawn from the ovens by the exhausters to the primary coolers, which are of the indirect vertical water-cooled type. In these coolers tar, naphthalene and a certain amount of ammoniacal liquor are condensed. Fig. 10, page 604, shows the three primary and the two final coolers. The cooled gas then passes through the exhausters to the tar extractors and reheaters. Two combined-type extractor-reheaters are supplied, one to act as standby. Here the tar fog is extracted and the gas is reheated to the requisite temperature for the efficient production of sulphate, prior to its entry into the saturators. There are two saturators, one acting as a standby. They consist of steel shells resting on cast iron bottoms, and are lead lined. The cracker pipes are also of lead. The gas bubbles through sulphuric acid and then passes through an acid separator to remove any traces of acid. A view of one of the saturators and acid separators is given in Fig. 5. The salt produced is removed by air ejectors and is drained

FIG. 9—OVEN DOORS AND SIDE BUCKSTAYS

in lead-lined draining boxes. It is then dried in centrifuges. Two of these operate and a third acts as a spare. These centrifuges are of the suspended self-balancing type and are driven by high-speed vertical steam engines. The ammonium sulphate is finally neutralised and dried in Phillipson machines, shown in Fig. 11.

An ammonia still is provided to distill the ammonia condensate from the primary coolers. The free section contains six trays, the fixed section nine. The ammonia so produced passes into the gas stream immediately before it enters the saturators. A steel storage tank with a capacity of 150,000 gallons is provided for ammoniacal liquor storage. The two steel tar storage tanks have a capacity of 60,000 gallons each.

After leaving the by-product building the gas passes through final coolers and is then de-benzolised in two tower scrubbers. These are 100ft. high and are packed with wooden hurdles. The gas passes up through the towers and meets a descending stream of wash oil which absorbs the light oils. The wash oil enriched with benzol is delivered into a distilling apparatus provided with the necessary heat exchangers, condensers and coolers. In order to effect heat economy two heat exchangers are provided. In the first the heat from the light oil vapours is transferred to the cold benzolised oil. In the second the hot de-benzolised oil is cooled, at the same time further heating the benzolised oil. Two final heaters are provided, one operating and one acting as a spare, in which the benzolised oil is finally heated before it enters the still. The light oil is distilled from the wash oil by intimate contact with steam in a cast iron still composed of a series of trays. The final cooling of the de-benzolised oil and of the light oils is effected in open type coolers. The wash oil cooler has eleven banks of 2in. galvanised pipes.

The benzol rectification plant consists of two stills, two agitators, and two naphthalene pans. One still is for distillation of crude light oil and one for motor spirit distillation. Each is equipped with a dephlegmator, a cooler and separators. The agitators wash the crude products with acid and soda. The still residues pass to the naphthalene pans where naphthalene is crystallised out. The principal apparatus for the recovery and rectification of benzol is housed in a steel-framed brick-filled building—see Fig. 6—which shows a general view inside the house. It is 41ft. long, 38ft. 6in. wide, and 44ft. high. The five wash oil circulating pumps are housed in a

"ican-to." An acid regenerating plant was supplied under a separate contract by Coke and Gas Ovens, Ltd.

In the process of rectification the benzol is washed with sulphuric acid of 97 per cent. strength. The acid sludge resulting from this process has always been a source of trouble to coke oven installations. In recent years, however, a plant has been introduced from which, in addition to recovering the remainder of the free acid, there is also recovered such benzol as is mechanically carried away by the sludge; but there has still been a pitchy residue for which no use has been found and which accumulates in the course of time on colliery refuse heaps. At Thorncliffe a new type of plant has been erected in which the free acid is removed from the sludge by stirring with mother liquor from the sulphate saturator, and the benzol is removed by distillation. Before allowing any part of the sludge to attain a high temperature it is mixed thoroughly with coke oven tar, and thus the substances which used to form a pitchy residue remain as tar and pass into the main tar storage tanks of the plant. Thus the whole of this sludge which has hitherto been regarded as a nuisance is recovered in a useful and profitable manner.

The power-house contains the following machines:—(1) Two direct-coupled steam turbine-driven high-speed turbo-exhausters, one only of which is required at a time, by Bryan Donkin and Co., Ltd.; (2) two Reavell motor-driven compressors, one operating and one in reserve; these machines are used for supplying surplus gas to the Sheffield Gas Company, and each is capable of taking 4 million cubic feet of gas per twenty-four hours and delivering it at a pressure of 15 lb. per square inch; the driving motors are of the synchronous type for power factor correction; (3) a Kent gas meter: one Connersville positive type meter, capable of measuring under normal load 6,500,000 cubic feet per day; (4) a Sentinel air compressor for compressed air services on the plant; (5) two liquor flushing pumps, one steam turbine driven and one motor driven.

In the same building there is provided a central manometer gauge board by the Cambridge Instrument Company, Ltd., showing all pressures throughout the by-product building. There are also recording and indicating pressure gauges for live and exhaust steam, compressed air and flushing liquor.

A general view inside the power-house is given in Fig. 12, in which the various machines mentioned above can be distinguished. This house also contains the electric power generation plant comprising two Belliss compound steam engines, each driving a 250-kW generator, and a National six-cylinder gas engine driving a 400-kW generator. When the whole of these generators are in operation, not only are the power requirements of the plant fully maintained, but there is also a considerable surplus of power available for sale to the Associated Colliery Company. We were told that the total power costs of the works amount to only 0·22d. per unit. The switchboard is by the Metropolitan-Vickers Electrical Company, Ltd.

Two water-tube boilers are provided for raising the necessary steam to supply the complete installation. Each is capable of supplying 20,000 lb. of steam per hour at 250 lb. per square inch pressure and 100 deg. Fah. superheat. They are equipped with mechanical chain-grate stokers for firing with coke breeze, and also with gas burner equipment for coke oven gas firing.

A gasholder with a capacity of 100,000 cubic feet is provided to ensure a supply of gas at constant pressure for use in the battery, boilers and boosters, and a "fleeder" or "torch" is arranged on some adjacent land where any surplus gas can be burned.

The complete by-product coking installation was designed and erected by the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., Allington House, 136–150, Victoria-street, London, S.W. 1. The power generation plant was, however, transferred from some old plants belonging to Thorncliffe Coal Distillation, Ltd.

Practically the entire constructional ironwork and steel work of the plant were produced by Newton, Chambers and Co., Ltd., and their collieries also supply the coal which is coked at these ovens.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE STEAMING ECONOMISER.

SIR,—Your leading article of May 23rd gives publicity to recent developments of the economiser which deserve to be widely appreciated. It is pleasing to note the fundamental difference between the boiler and the economiser so clearly brought out, the modern form of the steaming economiser being the result of the logical application of the principles of economical heat transmission.

With some of your generalisations regarding the relation between boiler and economiser heating surface, I must, however, join issue. You state, for example, that the rate of heat transmission in the economiser is much less than that in the boiler, partly on account of the less temperature difference between the gases and the water, and partly because of the relatively slower water velocity. This statement rather avoids the chief justification for the installation of an economiser. While it is generally true that the average rate of heat transfer in an economiser is less than the average rate in the boiler as a whole, the facts are quite otherwise when comparing the economiser with the average rate of transfer in the last passes of the boiler.

The average rate of heat transmission in the boiler is made to appear comparatively high by the inclusion of the very high rates obtaining in the combustion chamber and the first pass of boiler tubes. So far as the last pass of the boiler is concerned, the rate of heat transmission is far too often much lower than that attainable in a properly designed economiser.

The reasons for this are exactly those you have given in favour of the boiler itself. The facts can easily be demonstrated by examples from actual practice. If we take the case of an ordinary water-tube boiler working at 200 lb. per square inch, the temperature of the water in all parts of the boiler will, as you point out, be approximately the same, and equal to about 388 deg. Fah. It is common, though unsound, practice for such boilers to be designed to give an outlet gas temperature of about 550 deg. Fah. The temperature difference existing between the gases and the water in the last row of boiler tubes is thus 550 − 388 = 162 deg. Fah.

Suppose an economiser is installed to effect a reduction in gas temperature of 200 deg. Fah., bringing the gases down to 350 deg. Fah., as would be the case in a plant operating with natural draught. Under ordinary firing conditions the rise in feed-water temperature in the economiser corresponding to this drop in gas temperature would be about 100 deg. Fah. If the inlet feed-water temperature is, say, 150 deg. Fah., the average temperature of the water in passing through the economiser would be about 200 deg. Fah.

Similarly, the average temperature of the gases in the economiser would be 450 deg. Fah. Arithmetic means, though not strictly correct, have been taken for simplicity.

The average temperature difference between the gases and the water in the economiser is thus 450 − 200 = 250 deg. Fah. From the point of view of temperature difference, it is thus more logical to compare with the economiser the last part of the boiler, and not the boiler taken as a whole.

The next point concerns the rate of heat transmission per square foot per hour per degree of mean temperature difference, which is, as you point out, the only true criterion. So far as the last pass of the boiler is concerned, it is in this respect on exactly the same footing as the economiser, since practically no steam is formed in these tubes. The increased water velocity in the boiler is of practically no importance as regards rate of heat transfer, the chief resistances being on the gas side of the heating surface. The most important factor here is the velocity of the gases over the surface, and in comparing the economiser and boiler, since the weight of the gases remains to all intents and purposes the same, the question is one of relative flow areas.

The area of flow for the gases through a water-tube boiler is determined very largely by the width of the boiler, and this, in turn, is fixed by the dimensions of the combustion chamber. It is thus difficult to take special measures to increase the gas velocity through the last pass of the boiler, and it is rarely found that the rate of heat transfer per square foot exceeds 5 B.Th.U. per hour per degree Fah. in this portion.

The economiser, on the other hand, suffers from no such limitations. Provided sufficient draught is available, almost any gas velocity can be achieved by suitable design, with any type of separate economiser. The so-called "integral economiser," or "back element," is, of course, bound by the limitations of the boiler, and is in any case a survival of confused thinking in boiler design.

There is no reason why rates of heat transfer at least equal to those in the last pass of the boiler should not be achieved as an average in the economiser. As a matter of fact, rates considerably higher are very frequently obtained. In one power station in the Midlands an ordinary cast iron economiser is achieving rates exceeding 7 B.Th.U. per square foot, &c.

Add to all this the fact that economiser heating surface is generally at least 25 per cent. cheaper than boiler surface, the case for the small boiler and large economiser seems irrefragable. Incidentally it might be mentioned that in the case of the older Lancashire boiler cum Green's economiser plants, of which there must be many thousands in various parts of the world, the heating surface of the economiser is generally greater than that of the boiler. It must also be remembered in connection with your remarks on efficiency that such a combination, with induced and forced draught, but without the complications inseparable from preheated air, can often be made to achieve net efficiencies of the order of 80 per cent.

The temperature example given above is, I suggest, one of bad design which is unfortunately only too prevalent. The result is that purchasers are in most instances paying far too much for their steam plants, and are incurring capital charges which in these times they need not bear, and which they can easily avoid. They receive no assistance from the boilermaker, to whom they might present their case, as the latter can hardly be expected to reduce the amount of his profit for the benefit of the economiser maker, even if the result is to the advantage of his client.

On the other hand, power station plant is in some instances moving in this direction. Billingham is a case in point, and there are similar installations in other stations in this country. In a paper recently presented before the Institute of Engineers and Shipbuilders in Scotland by Messrs. Moultrop and Engle, read by Mr. Patchell, radical departures from conventional practice were described. The second and third passes of the boiler were omitted, leaving a single bank first pass, and the size of the economiser was considerably increased. It was stated that the design had shown itself a distinct improvement, both commercially and in operation.

A re-designing of the conventional type of water-tube boiler is overdue, especially in smaller plants. I see no reason why the heating surface should not be reduced to give outlet gas temperatures in the region of 800 deg. Fah., the boiler being followed by a suitable economiser, reducing the gas temperature to, say, 300 deg. Fah., or lower if possible. This alteration need not necessarily involve a steaming economiser; in fact, many Lancashire boilers actually do work with even higher exit gas temperatures and ordinary cast iron economisers. The result should be an appreciable reduction in the overall cost of the steam plant, unless the boilermaker quoted an artificial price to hinder such developments.

The argument is occasionally advanced that a reduction in boiler surface merely involves the shortening or removal of a few tubes, and the actual surface thus saved costs only about 2s. per square foot. This seems to be special pleading. A corresponding increase in the heating surface would probably be charged at full rate. The facts are that a re-design of the boiler on the principles enunciated would result in a cheaper plant, and the inclusion of an economiser of efficient design would enable a good overall performance to be attained at a lower capital cost than is at present possible.

The compulsion must, however, come from the purchaser, who must himself master the subject. The scientific aspect of the boiler and economiser problem has been known and appreciated for years. The application of these principles is slowly becoming more general, and has so far culminated in the steaming economiser. The difficulties which stand in the way of the free application of scientific knowledge to actual designs and installations are not, however, practical, as you suggest, but commercial. I believe it is well known that in most industrial countries the manufacturers of economisers and boilers are quite independent of each other, and are thus to a great extent in competition. Generally speaking, also, the boilermaker assumes the position of main contractor, and it is hardly likely that he will voluntarily reduce the amount of his own contract for the benefit of a competitor. It is only in those cases where a purchaser who is a competent engineer imposes on the boilermaker a specification which predetermines the ratio between boiler and economiser that he is likely to secure the most economical plant.

The principle on which such a determination should be based is simple, and the boiler exit gas temperature may be taken as the criterion. In order not to overstate the case for the economiser, it may be assumed that the cost of economiser surface is the same as that of boiler surface per square foot. If we further assume that the rate of heat transfer attainable per square foot per degree Fah. mean temperature difference in a modern economiser is no greater than that in the last pass of a water-tube boiler, we are again rather favouring the latter.

Under these conditions, I think it will be generally agreed that it would be uneconomical to extend the boiler surface beyond the point where the temperature difference between the exit gases and the water in the boiler is less than the average temperature difference, which can be achieved in a properly arranged economiser. A simple calculation will show that in the example given the temperature of the gases leaving the boiler should not be less than 667 deg. Fah. and might with advantage be higher.

You may recollect that Mr. C. E. Stromeyer once made a statement to the effect that it seemed as though the boiler ought to be proportioned to suit the economiser, and not the economiser to the boiler. Having the steaming economiser in mind, who shall say that events may not soon move in this direction?

May I add that a fairly complete discussion of this field is contained in a paper I recently presented to the Institute of Fuel?

O. KUBALEK.

Wakefield, May 26th.

THE UNEMPLOYMENT PROBLEM.

SIR,—It is not surprising that there are so many incorrect ideas current on so involved a subject as that of unemployment. Some ill-founded ideas are expressed in an attractive letter from Mr. R. Gaudin, which appeared in your issue of March 21st. I think that the matter is of such importance that his statements should be deposed.

He wrote "unemployment is a sign of progress," and "unemployment is inevitable."

Let us examine an elementary example. Picture a village of a century or so past, when practically every inhabitant worked from dawn till dusk, and extracted by their labour a bare subsistence. Possibly one of their irksome chores was getting water. Then there was fuel to be humped over miry tracks from the woods, which were some little distance off. One way or another, it was a weary family which kept the wolf from the door, and ill-tended sickness played havoc.

Presently, a piped water supply was introduced, coal was brought to the door, a bakery delivered bread, and the family found that their working hours were much reduced.

Suppose that in this small village twenty men and women working 10 hours a day produced all that the village required, and that after machinery was introduced the working hours were reduced to six a day. Some of these people might in their spare time install electric light, milk separators, &c., and cut down the working hours until by the introduction of mechanical appliances they reached the Nirvanic state, which I am always seeking, of winning what they needed by four hours' work a day. There would then be lots of time for tennis, music and picnics. Quite likely they would agree to work eight hours a day on alternate days. I should not describe those fortunate people as "unemployed" for half their time. Their leisure would have been obtained by the introduction of mechanical aids.

There is a further point which is overlooked when blaming mechanical appliances for unemployment. A machine may displace several people each day of its life,

but the fact is not mentioned that the making of that machine, and of the plant to make the machine, and of the buildings to house the plant, have employed, and continue to employ, many men-hours, in all probability almost as many as those which will be displaced. The output of the machine is available for distribution, and at least as great a quantity of produce is available for the use of the community, or country, as there would have been if each person had worked a full day on hand labour.

The cause or causes of unemployment have to be sought elsewhere. To any who doubt what I write, I suggest a mental scrapping of machinery. Let us, for instance, make our boots by hand, cut off the water supplies, and troop off to dally at the romantic well, scrap the railways and carry home our coal from the pithead. Such a nightmare of employment would result as would end in the extinction of most of the experimenters.

Amongst the causes of unemployment I include the following:—The increase of the population; the men-hours lost on making non-remunerative things, such as needlessly expensive and over-plentiful roads; pleasure cars, and on a host of ill-conceived ventures of which obsolete share lists tell the story; money spent abroad on materials, machinery, petrol, &c., and, the greatest factor of all, the war waste of billions of men-hours. At that time mechanical development was allowed to fall behind. Had there been no world war we could have installed vast quantities of mechanical appliances which would so much have promoted production that we could now all be living in comfort on a short working week.

C. TUNVILLE GARDNER,
Lagos, May 5th. A.M. Inst. C.E., A.M. Inst. T.

OUR UNIVERSITIES.

SIR,—I read with a good deal of interest the article published in THE ENGINEER of May 9th on the teaching of engineering in the universities. Many of the views there expressed I am in full sympathy with, after a teaching experience of thirty-four years in this university. The article rightly expressed the view that the professor should take an active part in the teaching of the students himself, and that the personal contact with a man of professorial rank is one of the valuable assets which the student derives from university training. Unfortunately, the tendency of later years has been to throw on to the professor a large burden of administrative work, and in my own case this has forced me into the position of coming in contact with the students only in their last year, and I do not see any way out of this difficulty with the present constitution of a university.

The suggestion that certain universities should devote themselves to the mathematical and physical sides of engineering, while others should lean more towards applications to industrial life, is, in my view, a very dangerous attitude to take. I fully realise that universities such as Oxford and Cambridge, with their academic surroundings, will not have quite the same outlook as a university such as Manchester, Liverpool, Birmingham, or Sheffield; but the principles on which the whole science of engineering rests are the same, and I think you will find that engineering schools of a university rank are teaching much the same work in all parts of the world, and that there is little or no difference between the teaching in England, Germany or America.

I can illustrate this point by a difficulty which I encountered quite early in my professorial career. Engineering teaching can be devoted to two aspects; the simplest is what may be termed descriptive engineering, dealing in a fairly close manner with methods of manufacture, forms of machines, and, generally, present positions of the engineering industry, and it could readily be illustrated by actual examples of machinery as manufactured by high-grade firms. Such teaching may give knowledge which is very useful at the time, but in future years it is bound to become obsolete, and then the student finds that he has derived little or no benefit from a university career. The other alternative is to confine the lectures almost entirely to the mathematical and physical side. In that case, of course, the results obtained are true within their own limits, quite irrespective of the lapse of time, and in that way a professor may claim that he is teaching the principles upon which engineering rests, and this is perfectly true, but it would be a profound mistake to consider that an applied mathematician with a good knowledge of physics is necessarily a good engineer. Engineering contains a great deal, as you know, which is not expressible in terms of mathematical symbols; in fact, I do not think it would be too much to assert that three-quarters of the knowledge required in the construction of anything like elaborate engineering machinery comes from knowledge which has no basis in mathematics and physics, and I feel that at present there is a very real danger in the engineering schools of this country, which are directed by men of the highest ability, and for whom I have a great admiration. Yet I feel that their teaching is not engineering at all, but merely a form of applied mathematics. Engineering teaching must, in my opinion, come back to an intimate knowledge of the properties of materials and their manufacture, and without this the students obtain comparatively little knowledge which will enable them to compete in the open market with those who have had no university training, but who are thoroughly familiar with the so-called practical side.

These are the views which I have arrived at after spending more than half my lifetime in teaching. I think it is possible to reconcile both the mathematical and what I term the manufacturing side of engineering, but it can only be done if the engineering schools of the country receive from the industry to which they minister, and from those people who are outside academic circles, the support and encouragement without which they cannot make any developments.

F. W. BURSTALL.
The University, Birmingham, May 20th.

The Treatment of Beet Sugar Factories' Effluent.

IN the Report of the Director of Water Pollution Research, which is embodied in the recently issued Report* of the Water Pollution Research Board for the year ended June 30th, 1929, some interesting information is given regarding the investigations which had been made during the year regarding the treatment of the effluents from beet sugar factories, so as to make them innocuous.

It is pointed out that, in beet sugar factories, the quantities of water discharged from the individual processes of manufacture per 1000 tons of beet treated vary considerably at different factories, but may be represented approximately as follows:—

(1) Water from condensers, which may be cooled and re-used for condensing or used direct for the transport of the beet, 2·5 to 3·5 million gallons.

(2) Transport and beet-washing water, 2·5 to 3·5 million gallons; often the same water as has been used for condensing.

(3) Diffusion and pulp press water, 300,000 to 500,000 gallons.

(4) Water for conveying spent lime to lagoons, 40,000 to 80,000 gallons.

The transport and washing waters carry considerable quantities of soil and beet *débris*, and contain small amounts of dissolved organic and inorganic substances. It was suggested in the first annual report of the Director that these waters might be re-used, provided satisfactory methods of removing the suspended solids could be adopted. Processes of screening and sedimentation have been tried on a large scale at certain factories, and those trials have, says the report, been attended with success, and it continues: "The re-use of the transport and washing waters is a definite step towards the solution of the problem of the disposal of the waste waters from beet sugar factories."

It is explained that at some factories the cosettes are extracted by continuous diffusion, instead of by the more usual intermittent process. In the continuous diffusion process the cosettes enter at the lower end of a large inclined cylinder, through which they are made to travel upwards by means of revolving arms on a central shaft. Water enters at the upper end of the cylinder, which is divided into sections, travels downwards and extracts the sugar from the cosettes. The spent cosettes leaving the cylinder at the upper end are pressed, and the press water is returned to the cylindrical diffuser. There is, consequently, no waste pulp press water or diffusion water for disposal. That, it is remarked, is an important step forward, for although the diffusion and pulp press waters to be disposed of by the intermittent process are much less in amount than the transport and washing waters, they are by far the most polluting of the waters discharged from any of the factory operations.

The water employed for conveying the spent lime to the lagoons should be just sufficient to enable the lime to be pumped as paste. This water, states the Report, either drains away slowly in the lagoons or is lost by evaporation, and need not give rise to serious complaints of pollution. If it should, later, be considered necessary to avoid the use of water for this purpose, the spent lime could probably be conveniently removed as a solid containing a comparatively small quantity of water. The water from condensers is generally employed for the transport of beet, though in some instances an excess over the amount required for that purpose has to be discharged. The condenser water contains minute quantities of ammonia, and is not of a very polluting character, but it is advisable that it should be cooled before it is discharged into streams. If the transport and washing waters can be treated to render them fit for re-use, then the large volume of condenser water will require cooling before discharge or it can be re-used for cooling purposes.

"It thus appears," goes on the Report, "that there is every prospect of solving or alleviating the problem of disposal of beet sugar factories' effluents by modification in the factory procedure and by treating the waste waters so that they may in large measure be re-used in the various operations. A certain amount of reorganisation in the factories would be required before the maximum re-use of water could be achieved. It is also appreciated that the continued re-use of the waters, even after retreatment, might result in a gradual accumulation of substances in solution to an extent rendering the waters unfit for further service, although this has not been found to be the case in factories in which the continuous process of diffusion is used. Such accumulation might necessitate the discharge of a small proportion of water from each process and the addition of a similar quantity of fresh water. Except in those instances in which the factory is adjacent to a comparatively large river, it would then be necessary to purify the waters before allowing them to enter the river."

The Report then proceeds to discuss the investigations which have been carried out by the Department regarding the treatment of these waters on percolating filters. Laboratory trials having given favourable indications, arrangements were made prior to the 1927–28 beet sugar campaign to conduct semi-commercial scale experiments in this direction at the factory at Colwick near Nottingham. There, the effluents available comprise fluming and washing waters, diffusion battery wastes, pulp press water, and miscellaneous effluents from the washing of floors, filter cloths, &c. The arrangement of the experimental plant is explained in the Report, and need not be detailed here. It will suffice to say that when the filters were employed to treat a mixture of pulp press water and other waste water with—after settlement—an oxygen-absorbed figure of 60 to 80 parts per 100,000, as measured by N/8 potassium permanganate at 27 deg. Cent. for four hours, and a five days' dissolved oxygen-consumed figure of about 120 parts, the best results obtained were equivalent to a purification of 70 to 80 per cent., with a rate of feed of 100 gallons per cubic yard per day. Measurements of the "time of contact" of each filter at the end of the campaign by Clifford's method, however, gave results ranging from 65 to 81 minutes, whereas laboratory experiments had indicated that a time of contact of about four hours was required if the desired purification of over 90 per cent. was to be attained.

During the summer of 1928, with a view to effecting improvements in the treatment process, certain changes and additions, which included alterations in the size of the filtering media, were made at the experimental plant. Drawings of the arrangements which were used during the 1928–29 campaign, and descriptions of the results obtained with it, are given in the report, to which those who are interested are referred. Here, it need only be said that, according to the Report, "the experiments have led to the conclusion . . . that over 90 per cent. purification of beet sugar factory effluents can be effected by the process of biological filtration on a large scale, but the quantity of suspended solids in the effluents to be purified should be reduced to a low value if the clogging of the filters and consequent reduction in efficiency of the process is to be avoided."

In addition to the investigations at Colwick, laboratory experiments were made at Rothamstead. They included investigations of the process of biological filtration of the effluents under various conditions, while the process of fermentation with intermittent additions of lime—as a preliminary to biological filtration—was also examined. The biological work during the 1927–28 campaign had demonstrated the large variety of the organisms taking part, either directly or indirectly, in the work of the filters. Sufficient information had not been obtained, however, to make it possible to specify particular organisms as being of outstanding importance. During the 1928–29 campaign, therefore, the general survey of the organisms was extended with the object of selecting those of sufficient importance to merit further study.

Bacterial platings were, we are told, made from samples of gelatinous material scraped from the medium of the filters at Colwick, first at weekly and later at daily intervals, and from each plating fifty colonies were taken for further examination. In that way about 800 bacterial cultures were collected. Each strain was, we learn, being tested on gelatine, and on several different sugars, and the results of the tests of the strains were being classified, but the full results were not, evidently, available at the date of the Report. It is remarked, however, that, "in addition to the bacteria which decompose sugar, it appears that bacteria capable of fixing nitrogen are present in the filter film. It seems probable that in the purification by biological filtration, the oxidation of the sugar occurs in stages, and that each stage of oxidation is brought about by a particular group of organisms."

It is added, in conclusion, that the material in the four filters at Colwick was removed at the end of the 1928–29 campaign, and replaced by new material of different grades of sizes. Certain minor alterations were also made to the experimental plant for a continuation of the investigation during the 1929–30 campaign. The results obtained are not, of course, as yet available.

* H.M. Stationery Office, price 9d.

SOME items of general interest were contained in the evidence given by Mr. Frank Pick in the House of Lords Select Committee's consideration of the London Electric Railway Company's Extension Bill. About 100,000 passengers a day were carried in public service vehicles converging on Finsbury Park. Tube trains might arrive at Finsbury Park simultaneously from the City and West End and discharge into the street 600 people who must try and find seats in omnibuses and tramcars which were already partly filled. Between Finsbury Park and Wood Green there were 109 trains a day, which, under the L. and N.E.R. counter proposals for electrification, might be doubled; but on the Underground Tooting Broadway line there were 459 trains a day. From five of the L. and N.E.R. stations concerned there were 12,000,000 passengers a year, but the Underground had 12,800,000 at Golders Green alone.

OIL-ELECTRIC LOCOMOTIVE FOR INDIA

THE GENERAL ELECTRIC CO., LTD. AND WILLIAM BEARDMORE & CO., LTD., ENGINEERS

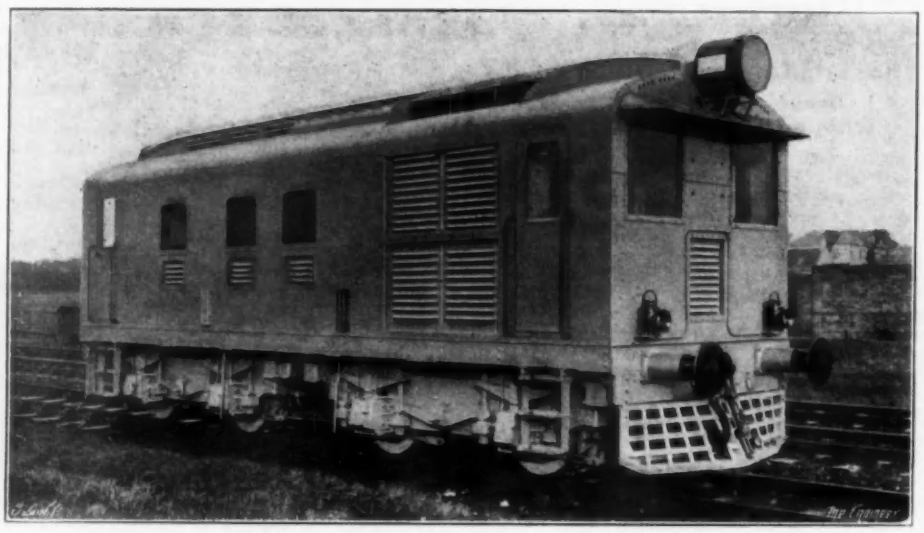


FIG. 1

Oil-Electric Locomotives for India.

WHERE water is scarce or bad and coal expensive or of poor quality, there is considerable incentive to seek an alternative to the steam locomotive. Even where these conditions do not obtain to any appreciable extent, this tendency may still prevail. Certain inherent advantages of the modern oil-electric locomotive, such as its high thermal efficiency and the possibility of putting it into service in a few minutes, coupled with the fact that it incurs no standby charges, have caused engineers in various parts of the world to investigate the possibility of employing these units. Other advantages are the absence of a boiler and fire-box, which call for periodical attention and the possibility of running these engines with a single man. As the amount of make-up water required by a Diesel locomotive is simply that necessitated by evaporation in the cooling water circuit, it is eminently suited for traversing long arid stretches of country where, with steam locomotives, water towers and filling troughs would have to be maintained and supplied with water at considerable expense.

On an oil-electric locomotive fitted with a "dead man's" handle, there is no necessity for a second man, which is a distinct advantage from a financial point of view on lines with sparse traffic. The problem of transmitting

FIG. 2—DRIVER'S COMPARTMENT

the power from the engine to the driving wheels is one of considerable importance, as the torque-speed characteristics of the oil engine are fundamentally dissimilar from those of the steam engine. For heavy duty locomotives the electric drive has been adopted in the majority of cases and the General Electric Company has recently completed preliminary trials of two oil-electric locomotives on a branch line of the L.M.S. railway in Scotland.

The locomotives illustrated herewith, which are electrically equipped on the Oerlikon system, are required for duty on short runs on main and branch lines of the North-Western Railway of India and are intended to meet the steadily increasing competition from road transport experienced during the last two or three years. For the service, high speed is essential, and it was specified that with a light load on a level track a speed of from 50 to 55 miles per hour should be possible, whilst with a train consisting of three bogie vehicles having a gross weight of 100 tons, the normal running speed should be 47 miles per hour, decreasing to 36 miles per hour on a 1 in 300 gradient and to 13 miles per hour on a 1 in 50 gradient. With native drivers ease of control and maintenance were also essential.

As will be seen from Fig. 1, the locomotives are of the double-bogie type without articulation, and in order to give easy riding qualities over rough tracks the wheels are side equalised. The superstructure which follows the recognised design for electric locomotives, consists of a long cab divided into three compartments. Driving compartments at each end contain a master controller, driver's brake valve for the vacuum brake, engine indicators, lighting switches, brake pressure gauge and other controls arranged for the driver's convenience, whilst the centre compartment houses the oil engine, generator, oil and water-cooling radiators, and other equipment. One of the driver's compartments is shown in Fig. 2, from which it will be perceived that the control equipment has been

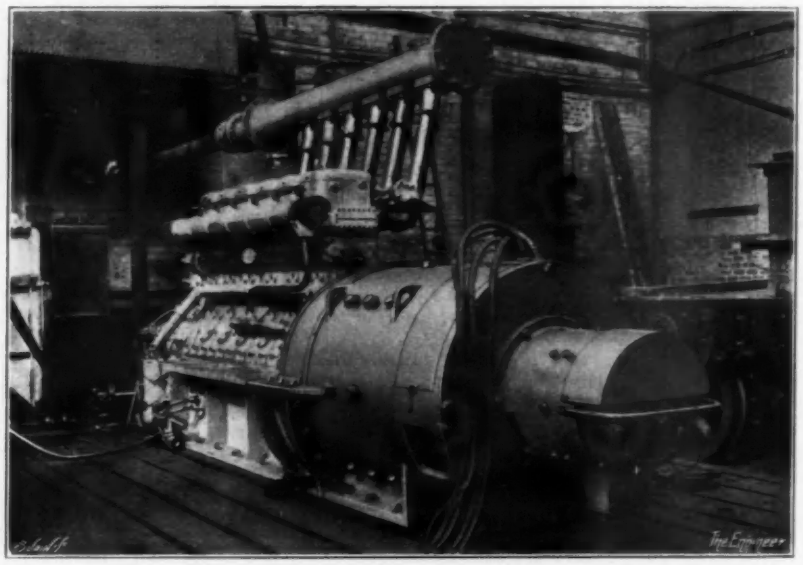


FIG. 3—ENGINE AND GENERATOR ON TEST BED

reduced to a simple form. The principal dimensions and data relating to these locomotives are as follows :—

Length over buffers	35ft. 10in.
Height over cab	12ft. 9in.
Width overall	9ft.
Total wheel base	23ft.
Wheel base of each bogie	7ft. 8in.
Centres of bogies	16ft.
Distance from rail to platform	4ft. 1in.
Diameter of wheels	3ft.
Track gauge	5ft. 6in.
Weight in running order	48 tons
Maximum tractive effort	10,000 lb.
Continuous H.P. of Diesel engine	350 H.P.
Number of driving motors	Four

In order to permit of trials in this country it was arranged that with a few modifications the locomotives could run on British lines having a gauge of 4ft. 8in. and conform with the British loading gauge. Wherever possible, components, such as tires, springs, brake blocks and sand boxes, &c., are of the standard sizes used on the Indian State Railways, and are, consequently, interchangeable with the corresponding components on the existing stock. The oil engine of each of the locomotives is a high-speed engine built by William Beardmore and Co., Ltd., and operates on the four-cycle, fluid pressure injection system. For some years engines of this kind have been operating on the Canadian National Railways and were originally developed to provide a light-weight engine of strong construction having a low weight-power ratio, which, in this particular case, has the exceptionally low value of 21 lb. per brake horse-power. The six cylinders each have a bore of 8½in. and a stroke of 12in. and when running at a speed of 900 r.p.m., the engine develops 350 horse-power, and for short periods this output can be increased to 420 horse-power. The engine forms a self-contained unit with its own water and lubricating pumps, both of which are automatically controlled. An engine and

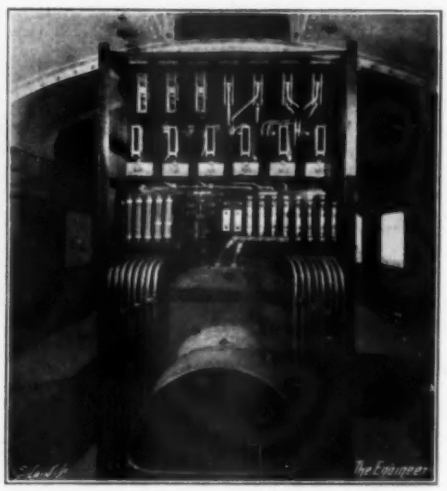


FIG. 4—GENERATOR AND CONTROL PANEL

generator erected on the test bed are shown in Fig. 3, whilst Fig. 4 gives a view of the inside centre compartment and shows the main control panel mounted over the generator. An important constructional feature is the steel monobloc crank case of the engine, which forms a rigid unit structure sustaining the longitudinal and transverse stresses set up by the motion of the parts. The crank case is bored to receive the steel liners forming the cylinder walls, and annular spaces are left between the liners and crank case to form a water jacket.

Large inspection doors give access to the big end bearings, whilst strong base supports cast integral with the crank case enable the engine to be rigidly bolted to the underbed. The lower part of the crank case is composed of an alloy steel casting and forms the oil sump, and the underside is arranged for bolting to the longitudinal members of the locomotive, whilst the end is extended for carrying the generator. The forged steel crank shaft and the connecting-rods are balanced and tested for weight distribution and the big end bearings are fitted with adjustable liners to take up wear. The aluminium alloy piston rings are machined all over and fitted with four piston rings. The cylinder head, which is also made of an aluminium alloy, is provided with large water cooling spaces. Besides a central automatic spray atomiser, each cylinder head carries two exhaust and two inlet valves. Compression release is obtained by lifting the inlet valves which, like the exhaust valves, are actuated by tappets from the cam shaft.

The motion from the tappets is transmitted to the valves by means of push rods and valve levers mounted in the cylinder head, and the valve gear is entirely enclosed by a light aluminium cover. From the crank shaft the cam shaft is driven by a train of gears housed in an end casing which also contains the gear wheel spindles for driving the cooling water and circulating pumps. The fuel pumps have three separate plungers each serving two cylinders, and there is a primary pump which maintains a low pressure on the suction side of the fuel pump and atomiser in order to

give correct timing. The injection is timed and the engine output controlled by varying the effective pump delivery stroke, and any excess of oil is returned to the fuel tank by a by-pass gear. The control of the speed of the locomotive is obtained primarily by variations of the speed of the engine governor, which is arranged for four definite settings, giving speeds of 400, 600, 750, and 900 revolutions per minute; while an overspeed device prevents the engine speed exceeding 1050 revolutions per minute by venting the fuel pump. The governor setting for these four speeds is controlled by a series of electrically-operated valves operated from the master controller in the driver's cab. It will be understood that this method of controlling speed by altering the governor setting affords several distinct advantages, such as economy in fuel consumption when travelling down gradients and the simple manner in which the variable horse-power output from the locomotive is obtained.

Lubrication is provided by a pressure system in which oil is drawn from a storage tank by a pressure pump at the gear case end of the engine. It is then forced through filters on the engine, through the crank case to the journals and pins and to the big end bearings. Another distributor

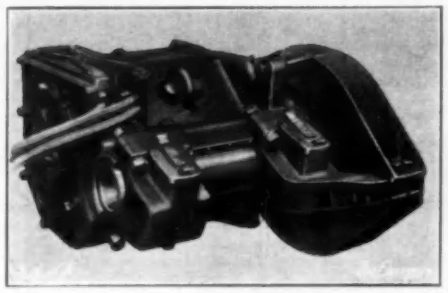


FIG. 5—TRACTION MOTOR

carries oil to the centre of the cam shaft, from which point the cam shaft bearings are lubricated. The oil is then returned to the sump, from which it is extracted by a scavenge pump which returns it through a cooler and filters to the storage tank. In the water and lubricating oil circulating systems monitor valves are inserted and are fitted with electrical contacts which, in the event of a failure of one or both systems, cause pilot lamps on the instrument panel in each of the driving compartments to be extinguished, thus giving visible warning to the driver. Two spiral gilled tube radiators are mounted on each side of the locomotive for cooling the lubricating oil and cooling water respectively and large fans driven from the engine draw air through each of the radiators, and the air is discharged *vid* ducts leading to the roof of the locomotive. After starting, a thermostat controlled by a by-pass ensures that the cooling water reaches the correct temperature as quickly as possible by allowing the water to short-circuit the radiator, and in the driving compartments temperature indicators are provided for both the cooling water and lubricating oil. The necessity for these instruments will be gathered when it is realised that in the

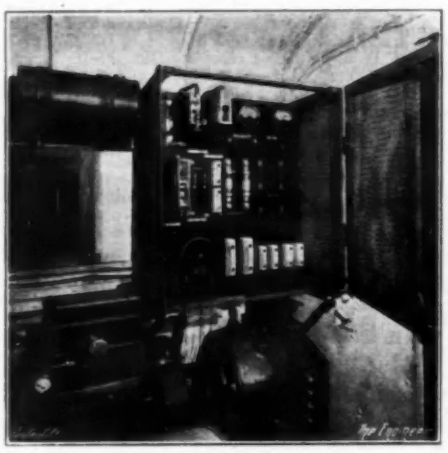


FIG. 6—AUXILIARY GENERATING SET

cold weather on this section of the line of the Indian railways, the temperature frequently drops below freezing point, whilst in the hot weather the air temperature rises to 120 deg. Fah. On the roof of the cab is mounted a tubular type exhaust muffler and each cylinder is connected to it separately by a pipe fitted with a flexible coupling.

Sufficient fuel oil is carried in a tank of 150 gallons capacity to enable each locomotive to run for seven hours on full load, and the oil is delivered to the main fuel pump at a pressure of 40 lb. per square inch by a booster pump mounted on the engine. The engines are started by supplying current from a storage battery to the motor generator, the control being arranged so that it is impossible for the driver to start the engine on full compression. Needless to say, this is an important point, as it considerably reduces the strain on the battery. A safety device is provided in the form of a special relay, which prevents the generator passing a heavy charging current to the battery in the event of the driver maintaining the starting connections after the engine has been started, the control consisting of a push button interlocked with the de-compression lever, both of which are mounted on the engine. For stopping the engine there are three push buttons, one in each driving compartment, and one in the engine compartment, and the driver is therefore always able to stop the engine under normal conditions or in the case of emergency.

The electrical equipment includes the main generator shown in Fig. 4, an exciter, four traction motors as shown in Fig. 5, electrical auxiliaries, control equipment, and other apparatus. The main generator, which is nominally rated at 250 kilowatts, supplies current at pressures varying between 100 and 800 volts, depending on the speed and loads. The machine has only one bearing, which is situated at the exciter end of the shaft, the other end of which is coupled to the engine fly-wheel by means of a solid spigot and bolt coupling, a form of construction which reduces the stresses which would be set up by the use of two bearings in the generator, in addition to those of the engine. The single bearing is of the Hoffman roller type, and is carried in a spherical seating to ensure self-alignment of the shaft. The cast steel frame of the generator is flanged at the coupling end to enable it to be bolted to a similar flange provided on the engine bed-plate, and as the unit is carried as a whole on the main frame of the locomotive, any tendency to distort is avoided.

In order to obtain a drooping characteristic, the generator is provided with an inverse compound winding, which has the effect of limiting the output of the machine, the winding being proportioned so that the engine can never be seriously overloaded. A simple adjustment of a variable resistance allows alteration to be made to suit special service conditions.

The overhung exciter conforms with normal practice, and is rated at 10 kilowatts with a normal voltage of 120. Actually, it would be more correctly termed an auxiliary low-tension generator, as it supplies current when running at speeds of 750 and 900 revolutions per minute, not only to the main generator field, but also to the vacuum brake exhaust motor, and it also assists in maintaining the battery in a charged condition. An automatically-

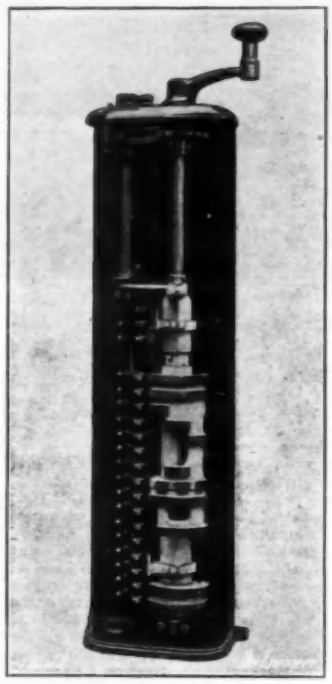


FIG. 7—MASTER CONTROLLER

operated series resistance in the shunt feed enables the exciter to maintain the same voltage at both the speeds mentioned, whilst below those speeds, namely, at speeds of 400 and 600 revolutions per minute, the battery supplies the total low-tension current required by the generator field, exhauster motor, lighting, and the control system. As in the case of the main generator, the exciter is designed with a slightly drooping characteristic, so that it automatically protects itself from heavy overloads. The normal voltage on the low-tension circuit is 110.

The four traction motors conform with standard practice. The normal one-hour rating is 120 ampères at 600 volts but they will carry considerably greater loads, and in order to give the normal running speed of 47 miles per hour, arrangements are made for shunting the field windings. The motors are hung from the axles, which are driven by reduction spur gearing enclosed in oil-tight grease cases. The armatures are carried by grease-lubricated roller bearings. Apart from the exciter, a small petrol engine-driven engine—Fig. 6—is provided for maintaining the battery in a properly charged condition. This auxiliary set is rated at 5 kilowatts and supplies direct current at 110/115 volts at a speed of 1200 revolutions per minute. During the normal running of the locomotive, the battery obtains sufficient charging current from the exciter, but as the locomotives may occasionally be used under abnormal conditions, in out of the way places, it was considered necessary to provide an auxiliary generating set for giving the battery periodical gassing charges. The battery installed on each locomotive consists of fifty cells of the K L 17 type, supplied by the D.P. Battery Company, Ltd., and has a total capacity of 224 ampère-hours at the five-hour rate of discharge. Each locomotive is equipped with separate vacuum and hand-operated braking systems and controls, which are to be seen on the right and left-hand respectively on the master controller in the driver's compartment—Fig. 2.

For the vacuum brake a small direct-current motor drives a Reavell exhauster, which requires about 3½ horse-power at normal speed and about 6 horse-power at high speed. Normally, the motor is supplied with current from the exciter when it is running at 750 or 900 revolutions per minute, but at the two lower speed settings it is fed from the battery. Although it necessitates a rather more expensive arrangement than that of driving the exhauster directly off the main engine, the system adopted results in improved working and reliability, whilst the speed of the exhauster can be arranged to suit the speed of the brake conditions, entirely independently of the speed of the engine. A driver's valve is provided, and when thrown into the fully released position, it automatically accelerates the exhauster for the release of the brakes. The master controller shown in Fig. 7 has an "off" position and eight operating steps—(1) engine speed 600 revolutions per minute, weak generator field, and full motor field; (2) engine speed as before, full generator field and full motor field; (3) engine speed 750 revolutions per minute, weak generator field and full motor field; (4) engine speed 750 revolutions per minute, full generator field and full motor field; (5) engine speed 900 revolutions per minute, weak generator field and full motor field; (6) engine speed 900 revolutions per minute, full generator field and full motor field; (7) engine speed 900 revolutions per minute, weak generator field and weak motor field; (8) engine speed 900 revolutions per minute, full generator field and weak motor field.

Reversing is carried out by means of the usual type of

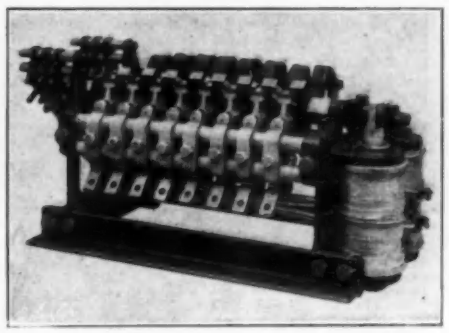


FIG. 8—REVERSING SWITCH

solenoid-operated reversers, as shown in Fig. 8, while the other operations are effected by means of contactors operated from the master controller and mounted on panels in the engine compartment. The main panel situated above the generator is to be seen in Fig. 4, and the auxiliary panel in Fig. 6. To ensure safety of the equipment interlocks are provided in certain cases, so that faulty connections cannot be made in the event of the controller failing or remaining closed. In the "off" position of the controller, the motor circuits are entirely broken by the appropriate contactors. The master controllers have the usual mechanical interlocks between the reverse and main drums and the engine is safeguarded against being started under load by the "off" position interlocks on the controller. For the control of the main generator field, two sections of resistance are employed, and one section is used only for the first step, so as to facilitate control of the locomotive when running light.

The locomotives were built to the specifications of the consulting engineers, Messrs. Rendel, Palmer, and Tritton. The complete electrical equipment was manufactured by the main contactors, the General Electric Company, while the engines and mechanical portions were constructed by the sub-contractors, William Beardmore and Co., Ltd.

SOME SCIENTIFIC INSTRUMENT MAKERS OF THE EIGHTEENTH CENTURY.

IN beginning his discourse on "Some Scientific Instrument Makers of the Eighteenth Century," which he delivered at the Royal Institution on Friday evening, May 23rd, Mr. R. S. Whipple, M.I.E.E., stated that there was little evidence to show that scientific instrument making, as a craft, had obtained a position of any importance in Great Britain before the sixteenth century, but the demand for instruments to assist navigation became more insistent as new lands were discovered and the length of the voyages increased.

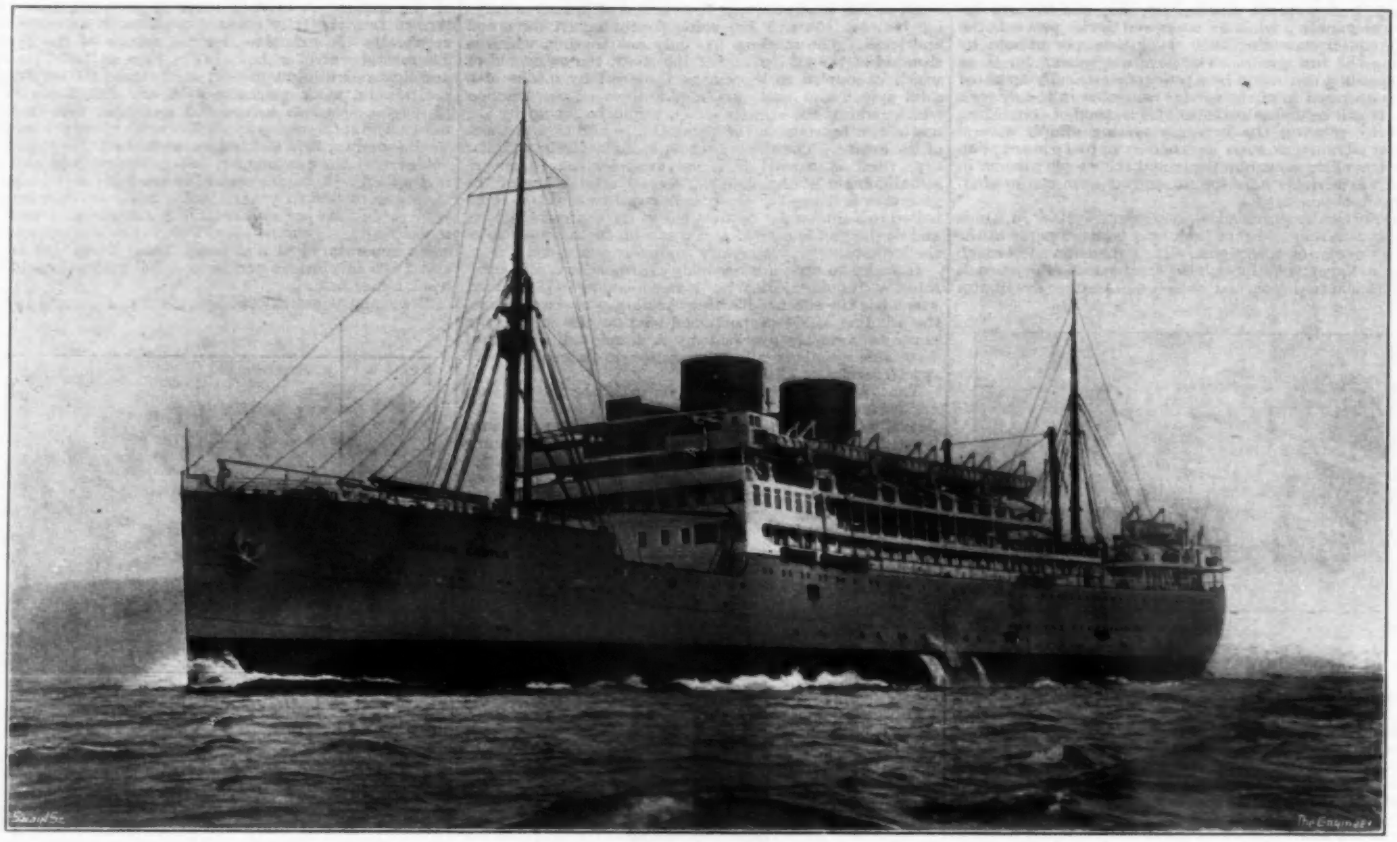
The discovery of the telescope in 1608 and the development of the microscope, largely due to Hooke and Loenwenhock in the middle of the seventeenth century, gave a great impetus to the manufacture of scientific instruments. John Marshall, by his skill in developing a method for grinding lenses and by the improved designs of his instruments, became the foremost instrument maker of the latter part of the seventeenth and of the early part of the eighteenth century. Benjamin Martin (1704–1782), who began life as a ploughboy, later became well known as an author of popular scientific books, and as an instrument maker. He developed many improvements in the microscope and other instruments.

One of his contemporaries, George Adams, became, perhaps, the best known instrument maker of the eighteenth century. He specialised in the manufacture of globes and surveying instruments, and also in microscopes. He also made a large number of instruments for George III., which are, fortunately, preserved in the Science Museum at South Kensington. They are outstanding examples of finished workmanship. A study of his manuscript note books of instructions for using the instruments has revealed some interesting points connected with the instruments. Some of the drawings were evidently the working drawings from which the workmen made the instruments. The note books show the attention given by Adams to the details of manufacture.

Mr. Whipple also referred to the names of Dolland, Ramsden and Herschel as outstanding instrument makers of the eighteenth century, regretting that there was not time to discuss their work, and the influence they had on the instrument industry.

THE UNION-CASTLE MOTOR LINER "DUNBAR CASTLE"

HARLAND AND WOLFF, LTD., GLASGOW, BUILDERS AND ENGINEERS



The New Union-Castle Motor Liner "Dunbar Castle."

THE new Union-Castle motor liner "Dunbar Castle" has been built at the Govan yard of Harland and Wolff, Ltd., and engined by the firm's Finnieston works for the Intermediate South and East African Service of the Union-Castle Mail Steamship Company, Ltd. On Wednesday morning of last week, May 21st, the ship with about one hundred guests of the company left the Tail of the Bank at Greenock for London, arriving at Tilbury at mid-day Friday, May 23rd. The voyage was a very smooth one and the absence of vibration was freely commented upon.

The following are the principal dimensions and particulars of this new liner :—

Hull Particulars.

Length between perpendiculars	470ft.
Breadth moulded	61ft.
Depth moulded	35ft. 3in.
Gross tonnage	10,002
Service speed	14½ knots
Maximum speed	About 15 knots

Passenger Accommodation.

First-class passengers	200
Second-class passengers	260
Open-berth passenger space (as required)	100

Propelling Machinery.

Type : Twin-screw, single-acting, four-stroke, Harland-B. & W. pressure-charged oil engines

Designed maximum output at 105 r.p.m.	6300 S.H.P.
Service output at 98 r.p.m.	5200 S.H.P.
Number of cylinders each engine ..	Six
Diameter of cylinders	740 mm.
Stroke	1500 mm.

Auxiliary Machinery.

Auxiliary generator sets, three oil-electric
Two Brown-Boveri exhaust turbine-driven blowers
Two Clarkson thimble-tube silencer boilers
Electrically-driven deck and engine-room auxiliaries and refrigerating plant .

The vessel has been designed in accordance with the latest requirements of the Board of Trade with regard to her subdivision, safety and navigational equipment. The hull is divided into nine water-tight compartments, and the double bottom, which extends the whole length of the ship, is designed to carry water ballast, fuel oil and fresh water.

A submarine signalling installation and also echo-sounding gear are fitted, and the lifeboats are carried in gravity davits of the Taylor design, supplied by Samuel Taylor and Sons, Ltd., of Brierley Hill, Staffordshire. The first-class passenger cabins and public rooms are ventilated on the punkah louvre system. Modern cargo-handling appliances have been fitted, and large insulated spaces are provided for perishable cargo, to which we refer later. The public rooms are large and spacious, and the decoration has been carried out in English country style, with a very pleasing result. The principal rooms include the dining saloon, the first-class lounge, and the smoking room, and there are both forward and after entrances and staircases. Similar accommodation is provided for the third-class passengers.

PROPELLING MACHINERY.

The principal particulars of the main and auxiliary propelling machinery are given in the above table.

The main engines are of the builder's standard design, and they are arranged for pressure-charging on the Büchi patented system. In addition, they are provided with fuel-valve lift control gear, as an aid to economical operation.

The hot gases from the exhaust manifolds are led direct to the two Brown-Boveri exhaust turbine-driven blowers. These units have been designed to deal with the gases at a maximum temperature of 980 deg. Fah., and at gauge pressures up to 8·7 lb. per square inch. The two blowers are each rated at an output of 11,000 cubic feet of air per minute, delivered at a gauge pressure of 4·27 lb. at the inlet manifold of the main engines. The speed of the blower units is about 4000 to 4500 r.p.m. During official tests the blowers were shown to have an efficiency of 53½ per cent. when operating with exhaust gases at 3·5 lb. per square inch before the turbine and 460 deg. Cent. and when running at a speed of 3700 r.p.m. Even when the engine output was increased to 50 per cent. above the normal output when working at atmospheric pressure, the blower plant continued to run with every satisfaction. After leaving the exhaust turbines the exhaust gases pass to two silencer boilers of the Clarkson thimble-tube type, one for each main engine. Each of these boilers has a heating surface of 270 square feet and is 5ft. in diameter with a height of 8ft. 6in., the combustion chamber being 6ft. 8in. high. Each boiler has a designed duty of about 2000 lb. of steam per hour at 100 lb. working pressure. They are equipped with the Clyde oil fuel burning system for port use and under oil-fired conditions the output of each boiler is about 2500 lb. per hour at the same working pressure.

The refrigerating plant is of interest, since the ship has been specially designed for the fruit trade. The plant was supplied and fitted on board by J. and E. Hall, Ltd., of Dartford, and it comprises insulated space in Nos. 1, 2, 4, and 5 'tween decks, having a total capacity of about 100,000 cubic feet. All these spaces are maintained at suitable temperatures for the carriage of citrous and deciduous fruit by means of cold air circulation. For each compartment there is a specially designed battery of brine pipes, with an electrically driven fan. No 2 space is specially equipped for carrying meat at low freezing temperatures, and there are also insulated chambers of about 8000 cubic feet capacity for ship's use, in addition to brine connections to pantries, &c. The refrigerating machinery is placed in a special compartment forward of the main engine-room, and it comprises three twin-cylinder CO_2 machines of the vertical type, each driven by a variable speed motor of 70 B.H.P. at a maximum speed of 350 r.p.m. The machines, which are totally enclosed, are provided with forced lubrication, and they run very quietly. There are three CO_2 condensers and three evaporators. The circulating water for the condensers is provided by a single large vertical centrifugal pump, while stand-by supplies can be obtained from other engine-room pumps. There are four vertical centrifugal pumps for brine circulation, and special arrangements are made for supplying brine at different temperatures, and also warm brine for thawing. Most of the other auxiliary machinery is of the electrically-driven type, current being supplied from the three auxiliary lighting and power sets already referred to in the table.

The trip from the Clyde to the Thames was a most enjoyable one, and on Saturday, May 24th, the "Dunbar Castle" left London for Antwerp, with the Lord Mayor of London and his party, who paid an official visit to the Antwerp Exhibition. The new liner is scheduled to sail on her maiden voyage to South and East African ports on Thursday, June 12th, and she marks another noteworthy addition to the Union-Castle Line fleet.

AREA GAS SUPPLY COMMITTEE.

THE Area Gas Supply Committee was appointed in January, 1929, with Sir Alexander Walker as chairman, to carry out the investigation recommended in the First Report of the National Fuel and Power Committee into the technical and economic aspects of an area gas supply system—mainly fed by surplus coke-oven gas—in the area lying between the Humber and Liverpool and between Leeds and Birmingham. The Report of the Committee has now been published and is obtainable from H.M. Stationery Office, or through any bookseller.

In brief, the Committee has agreed that an elaborate gas network system in the Midlands would not pay its way and that as conditions are at present, even limited networks in Lancashire and West Yorkshire cannot be justified. But they recommend the establishment of a gas network in South Yorkshire. The total length of its mains would be about 73 miles and it would be fed mainly by surplus coke-oven gas, *i.e.*, gas at present bled to atmosphere or wastefully used under boilers. The gas from the network, which, in the early stages of the scheme, is estimated to amount to 40 million cubic feet per day, rising later to 80 million cubic feet per day, would be absorbed mainly by the iron and steel industry in Sheffield and Rotherham. If the large consumers are to be induced to absorb these quantities, the average price would need to be about 2d. per therm—a low price, lower even than that now charged by the Sheffield Gas Company, which has a scale of charges that enables it to quote as low a price as any gas undertaking in the country. But on the calculations in the Report, it appears that even at that price for gas, the network would pay.

The Report includes a great deal of technical detail regarding the South Yorkshire Scheme. The Committee has not accepted the view of the South Yorkshire coke-oven owners, who urged that they should own and operate any network in their district, but recommends, as a general principle, that gas networks should be owned and operated by joint undertakings representative of the gas companies and coke-oven owners. In the case of the South Yorkshire scheme some members of the Committee are prepared to agree that the network might be owned and operated by the Sheffield Gas Company.

The Report refers to the question of the legislative restrictions on the gas industry. In the Committee's view, industry must have cheap gas, and if an expanding market for gas is to be found, a more scientific method of charge than that now generally operative is necessary provided a means is secured for affording protection to the "ordinary," or "domestic," consumer.

THE INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—The London Students' Section of the Institution of Electrical Engineers intends to hold a Summer Meeting in the Ruhr area and Switzerland during August of this year. The tour will commence on August 2nd and will finish in London on August 13th. The places visited will include Cologne, Essen, Basle, Zurich, and Interlaken. Those who intend to take part in the tour are requested to send their names and addresses to the hon. secretary, Mr. L. S. Crutch, 15, Mundania-road, East Dulwich, S.E. 22, as soon as possible.

Railway and Road Matters.

THE successor to Sir Josiah Stamp, in the presidency of the Institute of Transport, will be Sir Arthur Stanley, who will take office on October 1st next.

THE Canadian National Railways have been authorised by the Dominion Parliament to expend a further sum of 3,650,000 dollars on their Toronto termini, bringing the total expenditure on the part of the railway on this work up to approximately 17,000,000 dollars.

A WELL-KNOWN business train was concerned in a buffer stop collision on May 21st. It was the 5.20 p.m. express of the Southern Railway from Victoria to Eastbourne, the engine of which collided with and partly mounted the buffer stops at the latter place. Telescoping occurred between the second and third vehicles.

A PROMINENT railway engineer, Eugene Prosper Bender, died in Quebec on May 6th. He was for a long time in the employ of the Federal Government and of the Canadian National Railway, and took a great part in the construction of the New York elevated road, known as the Metropolitan. Mr. Bender had formed many companies, and was the first to advocate the construction of the Labrador railway.

APPLICATION has been made to the Canadian Parliament on behalf of a group of British capitalists who control large mineral desposits north of Lake Athabaska, for a charter to construct a railway to connect Fond du Lac, on Lake Athabaska, with Churchill, the new port on Hudson Bay, a distance of approximately 500 miles. This line would give the mineral areas of North Saskatchewan an outlet to the sea.

THE commemoration in Milan on Sunday last of the fifteenth anniversary of Italy entering the war prompts the remark that it was the discussion of that event by the two signalmen in Quintinshill signal-box on May 22nd, 1915, which mainly led to a local passenger train, standing on the up line, being overlooked and an up special troop train being accepted. In the wreckage caused by the consequent collision the down night express from Euston ran and the number of passengers killed was estimated at 224.

IN giving evidence before the Railway Rates Tribunal, in its annual review of railway revenue, Mr. W. V. Wood, one of the vice-presidents for operation of the London, Midland and Scottish Railway, spoke of the economies effected on that system. By reorganising one of its workshops and debiting the capital employed, £90,000 a year was saved and by closing another shop a further £17,000 a year was saved. Two or three of the carriage shops had been reorganised with a consequent economy of £9000, £11,000 and £12,000 a year. The reorganisation at Heysham and Fleetwood was saving £111,000 a year. By the standardisation of parts not only had costs been reduced, but the amount of stock had been brought down by £1,500,000.

THE 2½ per cent. reduction in the wages, salaries, and fees of railway servants, officers and directors, which was put into operation for twelve months in August, 1928, and subsequently extended until May 12th of this year, came to an end on the latter date. The railway companies wanted the extension to be for another year, but that was compromised by an agreement by the men that they would not ask for any variation in their pay or conditions of service until November 12th, 1930. The communication to the Press on this matter said that the return to normal rates of pay would cost the companies £2,500,000 a year. As it was announced by the chairman of the London, Midland and Scottish that that company saved over one million pounds by the reduction, and Mr. Whitelaw, of the London and North-Eastern, put the figure for his company at £820,000, it is fair to assume that the Great Western and Southern would bring the total up to £3,000,000 a year.

THE London Electric Railway Companies' Bill for the extension of the Piccadilly and Finsbury Park tube railway to Cockfosters passed the Committee stage in the House of Lords on Tuesday, the 27th. The alternative proposal of the London and North-Eastern Railway, as advanced on the previous day, was that the proposed powers, if granted, should be in suspense until December 31st next and should only then be operative on condition that the latter company had not commenced its scheme for the electrification of the suburban lines from King's Cross. If the L. and N.E.R., further, had begun that work it had to be completed within three years. The House of Lords Committee did not call upon counsel for the Underground to reply to that proposal. The Bill, it will be remembered, allows also for the extension of the same railway in a westwardly direction at Hammersmith and will not only give four lines of way beyond the latter station, but render it unnecessary for Richmond, Ealing, &c., passengers to and from the Picaddily tube to change at Hammersmith.

THE total number of passenger journeys—excluding season ticket holders—taken on all standard gauge railways in Great Britain in February, 1930, was 88,616,196, an increase compared with February, 1929, of 5,620,202, or 6·8 per cent. The journeys taken by passengers at reduced fares increased by 5,469,326, and those at standard or ordinary fares increased by 150,876. The receipts from passengers—excluding season ticket holders—showed an increase of £154,734, or 5·0 per cent. If the London Tubes and Metropolitan District Railway be omitted, the figures showed an increase in journeys of 4,147,649, or 7·0 per cent., and an increase in receipts of £138,251, or 5·0 per cent. For all companies the receipts from passenger train traffic—including season tickets and parcels and miscellaneous traffic, but excluding mails and parcels post—were £168,399 more than in February, 1929. The coaching train miles showed an increase of 455,930, or 2·2 per cent. The total tonnage of freight conveyed—excluding free-hauled traffic—was 27,147,646, an increase, compared with February, 1929, of 1,329,393 tons, or 5·1 per cent. Included in this figure were 17,433,172 tons of coal, coke and patent fuel, an increase compared with February, 1929, of 327,000, or 1·9 per cent. Freight train receipts amounted to £8,409,029—an increase of £144,910, or 1·8 per cent. The freight train miles run were 276,705 more than in February, 1929, an increase of 2·5 per cent. The average train load increased from 132 to 133¼ tons and the net ton-miles per engine hour from 422¼ to 451¼.

Notes and Memoranda.

BORINGS along the alignment of the proposed San Francisco-Alameda bridge show that depths greater than 300ft. will have to be gone to to reach bed rock.

THE United States now has 1000 research laboratories employing about 33,000 workers and expending annually about 210,000,000 dollars, according to Dr. H. W. Gillett, director of Batille Memorial Institute, Ohio. These figures do not include college, university and Government laboratories, nor control and testing laboratories.

THE introduction of nickel steel allows the employment of a much slower rate of cooling from the quenching temperature, so that oil can be used in place of water for this purpose. The risk of distortion, warping, and cracking is reduced to a minimum, so that much time and expense involved in subsequent straightening and grinding are saved and "wasters" avoided. In addition, the part is not left in such a state of stress as it may be after the more drastic water quenching.

ACCORDING to the *Engineering News-Record*, the bridge across the Second Narrows of Burrard Inlet at Vancouver, B.C., was again wrecked when the south approach span was knocked from its support on April 24th by the s.s. "Losmar." The ship was caught by an unexpected turn of the tide and swung from its intended course through the open bascule span into the 150ft. approach span. The accident interrupted vehicular and railroad service furnished by this bridge to the industrial and residential territory to the North. This bridge was completed in 1925 and has been the scene of eighteen or nineteen shipping accidents. A tidal current reaching a speed of 7 knots and a channel width between piers of only 160ft. have combined to produce a hazard to navigation.

THE construction of an experimental highway, with twenty half-mile lengths of various low-cost oil-treated surfaces, has, according to the *Engineering News-Record*, recently been started under the joint supervision of the United States Bureau of Public Roads and the California Division of Highways. The same two organisations will maintain the 10-mile stretch for three years, keeping account of the construction and maintenance cost as well as the service obtained, with a view to obtaining accurate comparative cost data for the various types of surface used. Some sections will be sealed before winter and others will be sealed later, depending on their action under weather and traffic conditions. The test road is situated in the mountains near the Nevada line, where the climate includes both severe winter conditions and warm, dry summers.

ACCORDING to reports on oil drilling operations in Alberta, compiled by the Dominion Department of the Interior, the 1929 production was 999,152 barrels, of which 981,221 barrels were produced in the Turner Valley. Besides the Turner Valley, other fields contributing to the total were the Wainwright with 12,332 barrels, the Ribstone with 2839 barrels, the Skiff field with 1432 barrels, and the Red Coulee field with 1328 barrels. The Wainwright, Ribstone, and Skiff fields are credited with heavy crude oil production—30 deg. and under—whereas the output of the new Red Coulee field is rated as light crude, or between 30 deg. and 60 deg. Turner Valley secured a production of 9841 barrels of naphtha—60 deg. and over—and the remainder 72,480 barrels was in the light crude grade. The production of oil in Alberta last year was more than doubled in comparison with 1928. The production figures for the last five years show the output for 1925 as 168,643 barrels; 1926, 219,598 barrels; 1927, 332,133 barrels; 1928, 489,531 barrels; and 1929, 999,152 barrels.

MAIZOLITH is a dense, hard, bonelike material, ranging in colour from a golden tan to a deep ebony. It is somewhat heavier and stronger than the hardwoods, and is a good electrical insulator. In the preparation of maizolith, cornstalks which have been shredded to lengths of 1·5in. to 3in.—or corncobs roughly broken up—are digested about three hours under 40 lb. steam pressure with caustic soda equal to 10 per cent. of the weight of the bone-dry stalks and diluted to a 1 per cent. solution. The cooked pulp is then washed free of the caustic liquors. These cooking and washing treatments leave a pulp that for all practical purposes may be considered pure cellulose. The pulp is then diluted to a consistency of about 4 per cent. and is gelatinised by treatment in a beating engine and a Jordan refiner until a jelly-like mass is obtained. This jell is boiled to remove air bubbles, placed in a mould with a perforated bottom and having a plunger top which exerts a pressure of about 0·5 lb. per square inch on the jell, and dried in the mould at about 70 deg. Cent. The time for drying sheets ¼in. thick is about ten days. On drying, the maizolith shrinks to about one-fourth of the volume it occupied when moulded.

COMMENTING on a Canadian Department of Mines report on the bituminous sands of Alberta, *Nature* says:—"In the course of drilling through unoxidised bituminous sand, the action of cold water promoted a ready separation of the bitumen from its host, and as much as 96 per cent. bitumen was recovered from one sample by scraping it from the cable-tool bit. Where the bituminous sand has been exposed to the action of the weather for any time, separation is not so readily effected; but it is a fact that most separation processes have been based on material taken from outcrop; that is, subject to atmospheric action. It would be a point of both scientific and economic importance to know what resistance to separation is manifest by bitumen which has been made to impregnate sand the constituent grains of which are coated to a greater or lesser extent by limonitic films; whether, given the same degree of bituminous saturation, a non-ferruginous sand—for example, glass sand—or a strongly ferruginous sand would give up its hydrocarbon content to water-flush more readily. Alternatively, it may not be a question of the sand grain coating at all; possibly the facility of separation is a function of the freshness of the bitumen itself, for clearly where this material is exposed to the atmosphere it undergoes changes which cannot be set up so long as it is hermetically sealed from the influence of meteoric water. One cannot help feeling that both possibilities must be taken into account.

Miscellanea.

A RAYON factory, said to be the largest of its kind in Russia, has just been completed in Leningrad.

DURING the month from March 15th to April 16th, 70,400 tons of oil passed through the Baku–Batoum pipe line.

THE Madras Legislative Council has sanctioned the grant of a sum not exceeding Rs. 5,50,000 for the supply of electric power to Erode and Salem from Mettur.

A WIRELESS service has been organised on some of the trains of the Canadian National Railways, which enables passengers to telephone to places as far distant as London.

A NUGGET of native metallic copper, weighing 600 lb., has been found at Coronation Gulf, on the Arctic Ocean. It has been placed in the National Museum of Canada at Ottawa.

ANOTHER White Star liner, the "Runic," has been purchased by the Norwegian Whaling Company for conversion into a floating factory. She will be the third vessel of that line to be so converted.

IT is announced that the Bulgarian Government is contemplating the invitation of tenders for the building of an iron and steel plant near Sofia or Rustchuk, for which the co-operation of a Central European steel works group has been already secured.

THE *Rangoon Times* understands that the scheme for the extension of civil aviation between India and Burma, which has been under consideration by the Government of India, has been approved, and definite steps are now being taken to develop the scheme.

PLANS are going forward for a large oil refinery which the Shell Oil Company, of British Columbia, proposes to build on a water-front site in Burnaby municipality, adjoining Vancouver. It is unofficially reported that the project will mean the eventual spending of 4,000,000 dollars on construction of the refinery and of the ocean and railway termini, which are a necessary part of the undertaking.

THE Chinese National Reconstruction Commission has called a meeting of representatives of the Kiangsu Provincial Government, the Special Municipality of Shanghai, and the General Chamber of Commerce at Shanghai to discuss the proposed dredging of Woosung and the Whangpoo River to facilitate shipping. The scheme has been under consideration for some time and part of the necessary finance is now available.

THE Aviation Department of the Chinese Ministry of War is planning to construct a number of aviation fields in various important centres in the country to provide landing places for the Government aeroplanes. Among the first of such fields to be opened will be those in Yingchowfu (Anhwei–Honan border), Chowkiakow (Eastern Honan), Tsining and Tsaochow (Southern and South-Western Shantung), Kweiteh (North-Eastern Honan), and Lincheng and Ichowfu (South-Eastern Honan).

THE Council of the Royal Institute of British Architects has arranged to celebrate the reopening of St. Paul's Cathedral on June 25th, after many years' reconstruction work, by a special general meeting on Monday, June 23rd next, at 8.30 p.m., at which a lecture dealing with the Restoration of the Cathedral will be delivered by Captain C. Stanley Peach and Mr. W. G. Allen. The lecture will be illustrated by slides and by an exhibition of models, masonry specimens, drawings, and photographs, which will remain open till June 28th.

Two villages and part of a third, involving in all forty-five farms, which provide the livelihood of 560 people, would be submerged if a scheme for the creation of an artificial lake in the Upper Rhine Valley were to be carried out. The proposal was discussed at a numerously attended public meeting at Coire on May 23rd. The scheme, which includes the construction of a big electricity power station, and would, it is estimated, take from ten to twenty years to complete and cost approximately £8,000,000, was opposed by spokesmen of the Upper Rhine area, and the meeting ended in no decision being come to.

THE official returns rendered to the Electricity Commissioners show that 837 million units of electricity were generated by authorised undertakers in Great Britain during the month of April, 1930, as compared with 807 million units in the corresponding month of 1929, or an increase of 3·7 per cent. During the first quarter of 1930 the total amount of electricity generated by authorised undertakers was 3017 million units, as compared with 2844 million units for the corresponding quarter of 1929, representing an increase of over 6 per cent. The Commissioners propose to issue a similar statement each month.

ON May 28th the new fire extinguisher factory of the Pyrene Company on the Great West Road, where it is crossed by the Great Western Railway, was formally opened by Lord Brentford, when a party of some 300 guests was entertained to luncheon by the company. In urging the importance of attacking fires early in their inception and at their origins, Lord Brentford said that fires annually involved the death of 1500 people and a loss of £15,000,000. A demonstration of putting out an oil fire in a 30ft. tank was given. The surface was covered with about 6in. of foam in 1 min. 50 sec., and the fire completely extinguished.

IN anticipation of Government approval and assistance being accorded to the Grand Union Canal Company's £500,000 development scheme, experiments to discover the best and most economical method of strengthening the weak places along the banks of the canal are being undertaken. Traffic has increased considerably within the last twelve months, and the advent of a constantly increasing number of motor boats of larger carrying capacity has resulted in an aggravation of the bank erosion. As the canal is 240 miles long, the cost of reinforcement is necessarily heavy. The problem confronting the company's engineers, in view of the extensive developments now contemplated, is to discover by test and experiment the best method of counteracting erosion. Wallings of different types have been built at many points along the canal, and the authorities are hopeful that by the time the new scheme is in operation, they will have found a permanent method of protecting the canal banks.

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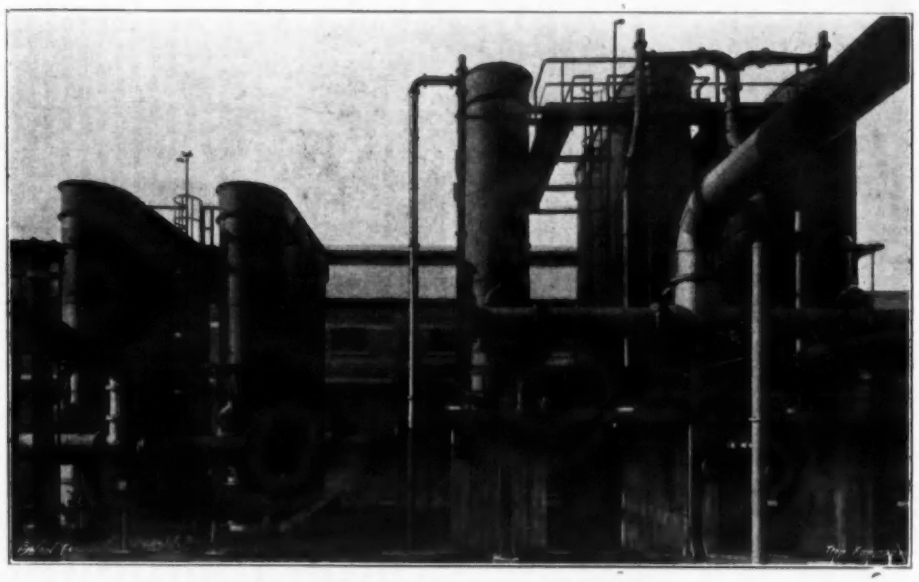

FIG. 1—PRIMARY AND FINAL GAS COOLERS

FIG. 11—SULPHATE NEUTRALISERS AND DRYERS

FIG. 12—EXHAUSTER AND PUMP HOUSE

FIG. 13—REVOLVING-PLATE COAL FEEDERS

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The Metallurgist.

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THE ENGINEER.

VOL. CXLIX No. 3881

MAY 30, 1930.

The Registration of Engineers.

ON May 2nd, the Société des Ingénieurs Civils de France held an extra-ordinary session, the official report of which has just reached us. On the suggestion of M. Monteil, a Vice-president, and President of the Fédération des Associations, Sociétés et Syndicats français d'Ingénieurs, a symposium upon that ever-vexed question of the registration of engineers was held. The speakers were the Rector of the University of Lille; the Vice-president of the Fédération just named—a body which resembles, upon a more comprehensive scale, our own Engineering Joint Council—a past-president of the Association des Ingénieurs de l'Institut industriel du Nord de la France; the President of the Syndicat Union Sociale d'Ingénieurs catholiques; M. Guillet, well known in this country, Membre de l'Institut, Past-president of the Société des Ingénieurs Civil, and director of the Ecole Central des Arts et Manufactures; M. Monteil, and, finally, Me. Edmond Bloch, avocat à la Cour d'Appel, and avocat-conseil of the heretofore named Fédération. We quote all these long qualities so that our readers may be in no doubt about the exalted positions held by the speakers. Wisdom is not the exclusive prerogative of those in high positions. More lowly people may possess quite as much and express it with equal ability, but—such is the world—a statement backed by a fine title has many times the value of the same statement, in the same words, springing from the lips of an unknown. Indeed, none of these great men said anything that has not been said before, but their positions give authority to their *obiter dicta* and their words will weigh not only in France, which appears to be resolved upon the passage of a measure for the protection of engineers, but in other countries as well.

In a symposium upon a subject so difficult some differences of opinion were bound to make themselves evident, but after a careful study of the report we think we may advance one or two conclusions as generally accepted by the meeting. It seemed to be agreed that whatever might be done to effect the registration of engineers, the universities should still be allowed to confer their own degrees and diplomas, and that those awards should qualify the possessors to call themselves Engineers. In other words, although the power to dub approved persons engineers may, ultimately, reside in the State itself, the degrees given by universities shall rank as of equal value with the awards of the State. One of the speakers, however, was exercised about the position of private technical schools, fearing that their diplomas would no longer be recognised. He proposed that a State commission, of which half would be composed of engineers, should control the awards made by such schools. The familiar difficulty presented by the position occupied by the self-taught engineer was discussed by all the speakers. The only solution seemed to be to hold an examination of one kind for those who had studied, and of another kind for those who had acquired merit by their works. Questions arose over the registered title. M. Guillet declared that a law regulating the use of the term "Engineer" should be passed, but at the same time he held that the name of a college granting the degree should be clearly stated. Other speakers pointed out that owing to the many divisions of engineering the title engineer might be misleading, and that it would be desirable to qualify it—as, for example, Civil Engineer, Mechanical Engineer, Electrical Engineer, Sanitary Engineer, and so on. Finally, M. Monteil, at whose wish it will be recalled the conference took place, said that the Fédération which he represented did not believe that the protection of engineers by law was either necessary or desirable. Hence, we see that opinion on the whole matter is as divided in France as in this country, although it would be true to say that there, as well as here, there is a general feeling that something should be done to distinguish between those who are qualified by education and training and those who are no more than artisans. The diplomas and degrees given by the universities and colleges have the same effect as those given by the Colleges of Surgeons and Physicians; they indicate to the public that the holder has had an education which makes him worthy of trust. The membership of the greater Institutions has in one sense rather less and, in another sense, rather more value. It may not show such a high degree of learning, but it does show that the member has already held a position of responsibility.

The desire to control the use of the title "Engineer" is largely sentimental in origin. The man who has devoted years of his life to his education and training does not like to find himself classed with the engine-driver and the mechanic; he feels that some means of distinguishing between the highly trained and the untrained should exist. When the builder of a great bridge, or a great machine, reads in the newspaper "Engineer Absconds with Goose Club Funds," he feels annoyed that in the public mind he and the absconder are not separated. The sentiment is a very human and natural one, but it is without material effect—the city that wishes for a new bridge, or the company that wants a new machine, does not go to the mechanic for it just because he calls himself an "engineer." It makes a selection on quite other considerations. It is true that at times a man with insufficient training and insufficient experience may be given work to do for which he is unfitted; but we fear that even the registration of engineers could not stop that. The best protection of the public and of engineers themselves lies in the hands of the great scientific and technical institutions and colleges. By insisting upon high qualifications they can raise the status of engineering, and we may be confident that in the course of time the public will employ only those who are members of such bodies. Many of those institutions are now chartered and we suggest that all bodies which are honoured in that way by the King should regard themselves under a special obligation to raise the standard of their membership in all respects. Under the Royal Charter recently granted to the Institution of Mechanical Engineers, the Corporate members are privileged to call themselves Chartered Mechanical Engineers. That is an effective kind of registration. In the eyes of the public men so describing themselves will appear as worthy of trust. It must be for that Institution, as for all others similarly privileged, to make sure that the members are, indeed, worthy of the title and of the reputation which accompanies

it. Most of such institutions are already careful about the quality of their membership, but both for the benefit of their members and the protection of the public, it is imperative that the qualification of applicants should be ever more and more jealously examined. In the desire for increased membership, some societies are lax in their investigations of claims to admission. That is the wrong direction in which to move. In the course of time, the initials of the great institutions will have the same value as the M.R.C.S. and L.R.C.P. held by doctors, and only those who have a right to use them will be employed upon important work. The inevitable result must be that all who wish to make progress in their profession will seek to become members. Membership of one or other of the recognised institutions will then be as complete and as effective as any form of State registration, and the danger of incompetence finding employment upon important work will be remote.

Interference Between Power and Communication Circuits.

WITH the ever-increasing use of electricity for power and general purposes the problem of finding ways and means of avoiding interference with communication circuits is one of great importance. On many occasions communication engineers have referred to the troubles power circuits sometimes cause them, and have urged those on the heavy side of the electrical industry to take all possible steps to minimise the disturbances. During the course of his presidential address before the Institution of Electrical Engineers in 1922 Mr. Frank Gill remarked that it must be recognised that the telegraph and telephone branch of electrical engineering and the lighting, power and traction branch were both necessary to the well-being of the world, and those connected with the two sections of the profession must learn to live together harmoniously and strive to avoid or mitigate reactions between their circuits. In grappling with the difficult problem there ought not to be any claim on either side for priority or protection or preferential treatment. It is wrong for the heavy current interests to assert that the light current industry must take care of itself, and it is equally inconsistent for communication engineers to insist that in no circumstances must their existing arrangements be disturbed. Much has been published from time to time in this and other countries on interference between power and communication circuits. Single-phase railway systems have apparently proved particularly troublesome, but as a study of the literature on the subject will show, interference arises from a variety of sources.

Thanks to the British Electrical and Allied Industries Research Association, a considerable amount of data on telegraph and telephone interference has been placed at the disposal of engineers. In 1922 the Association formed a Committee on Telephone Interference, but before considering experimental work, it was decided to make an exhaustive survey of what had been done. For that purpose Professor C. Parker Smith, with Mr. S. A. Knight as his assistant, was appointed to make a *résumé* of all the available information on the subject. A report covering information prior to the middle of 1925 was presented by Professor Smith in March, 1928, and this month's issue of the *Journal* of the Institution of Electrical Engineers contains a brief summary of the material included in the report. The original digests prepared by Professor Parker Smith, together with more detailed data from the articles digested, have been filed at the offices of the British Electrical and Allied Industries Research Association for the benefit of engineers who may wish to refer to them. In causing this work to be carried out, the Association has rendered valuable service to the electrical industry, which has long been in need of a comprehensive collection of literature on interference between power and communication circuits. The *résumé* published in the *Journal* of the Institution of Electrical Engineers deals with various aspects of the subject. Methods are given for calculating the voltage induced in telephone and telegraph circuits, owing to the disturbing influences of heavy current or high-tension open-wire power lines, and attention is paid to the design of power and traction circuits and telegraph and telephone circuits, with a view to minimising interference. It has long been known that inductive effects from both current and voltage under normal operating conditions of a power circuit may be greatly reduced by transposing individual conductors of the power and communication circuits at definite intervals. Possibly, however, the best transposition schemes are not well known, and various plans that have been tried are therefore outlined, and those that have proved to be the most successful are indicated. In order that any transposition scheme may be fully effective, there must be close co-operation between the power and communication authorities, who, as Mr. Frank Gill has pointed out, must work together for the common good of the public. Another well-known fact to which the summary of Professor Smith's report alludes is that disturbances to normal telephone working are generally attributable to the presence of high-frequency harmonics in the power circuit, but certain modifications in the design of rotating machines enable these harmonics to be reduced or eliminated. The effect of higher harmonics on a telephone receiver is to produce noise which reduces the transmission value of a circuit and may interfere with speech or render it impossible. The use of land lines for the purpose of simultaneous broadcasting has added importance to this branch of the subject; in fact, the suppression of harmonics is the principal thing to be aimed at. The various schemes which the summary of the report describes for securing the desired result should prove of value to electrical designers, who, as Mr. Bartholomew, of the Post Office, and others have often pointed out, can do much to diminish the communication engineer's troubles. The various means of getting rid of harmonics are too numerous, and in some cases too involved, to be considered in detail here. Let it suffice to say that, apart from introducing special features in the design of machines, a shunt placed across the source of the ripple and adjusted to the frequency of the harmonic requiring to be eliminated, has been found to be of great value when the ripple present is due to one pronounced harmonic. This remedy is, of course, well known, and was adopted years ago on the Rjunkan Railway in South Norway. More recently, it has been applied with marked success to mercury vapour rectifiers, which in the absence of an arrangement of this kind are very apt to give rise to communication troubles. Resonance shunts have been used to eliminate the tooth ripples from direct-current machines. A battery floating across the terminals of a rotary converter has also proved effective in reducing interference to adjoining telephone circuits.

But there are remedies apart from those that can be applied by designers and which must not on any account be neglected. Unfortunately, the summary of the report does not deal very fully with troubles arising from traction circuits. The single-phase traction system, which is alleged to have given rise to very serious communication troubles, receives very little attention, but possibly more information concerning this matter is to be found in the papers filed at the British Electrical and Allied Industries Research Association's offices. On direct-current railways the most serious disturbances occur during short circuits and in order to limit the duration of these transient conditions, high-speed circuit breakers have been developed. From a general survey of the available information, it would seem to be possible with the experience gained to suppress all inductive interference from all sources, with the possible exception of short circuits, although, according to the summary of the report, the elimination of interference may not only entail capital cost, but also a high degree of maintenance on the part of power and communication authorities. Later work is under consideration by the Association and a supplementary report will be issued in due course.

Incorporated Municipal Electrical Association.

No. I.

THE thirty-fifth annual Convention of the Incorporated Municipal Electrical Association is being held in Eastbourne this week, the President being Mr. J. K. Brydges, who has held the position of borough electrical engineer since 1899, at the time when the old Eastbourne Electric Light Company was purchased by the Corporation. As is usual at these functions, the Association was given a civic welcome by the Mayor, and beyond the usual felicitations it was to be noted that the Mayor, looking at the matter from the purely æsthetic point of view, complained of the erection of the Central Electricity Board's towers over the Sussex Downs, whereas Mr. Brydges, in his presidential address a few moments later, taking the purely practical aspect, expressed the opposite view, and suggested that in a very short time the towers would become part of the landscape and nobody would complain. Incidentally, it may be mentioned that the Eastbourne station is one of those that will eventually be shut down.

The proceedings started on Tuesday, May 27th, when, as stated, the Mayor gave the Association a civic welcome in Devonshire Park. This was followed by the presidential address, which largely concerned itself with an account of the advent of the Central Electricity Board and the work of the Electricity Commissioners. Some up-to-date figures of the "Grid" scheme, however, may be mentioned. Seven areas have been adopted by the Central Board under propositions of the Electricity Commissioners, embracing 68 per cent. of Great Britain in area and 95 per cent. of the population. In these areas 116 stations have been "selected" and 340 will ultimately be closed down. In the whole of the practical area there are 620 undertakings possessing 490 generating stations. Contracts for nearly £11,000,000 have already been placed, and over two sections of the "Grid" current has already been passed. It has been arranged to spend a similar sum on the standardisation of frequency, and the Electricity Commissioners estimate that their first six area schemes will reduce the cost of production by £11,000,000 in six years. Mr. Brydges seemed a little sceptical on that point, as indeed he was on a number of the anticipations of those responsible for the Government scheme. For instance, he foreshadowed that reductions in charges for electricity in many areas which would have been forthcoming would be delayed through the Government proposals, and he concluded some rather gloomy comments on the scheme by saying that the results were all in the lap of the gods, and that we must wait with what patience we could for the golden age which had been promised us. He recognised that he was a little pessimistic, but said that he felt it his duty to point out the many obstacles that had to be faced before we could arrive at the electrical millenium that had been so confidently predicted in more than one quarter.

Discussing the Central Electricity Board's towers over the Sussex Downs, Mr. Brydges took a wide view. The amenities of the countryside, he said, must, in an essentially commercial community like ours, occasionally suffer. To put all the main transmission lines underground, he agreed, would have swamped the new scheme entirely, and he confidently anticipated, he said, that within the next year or two we should have entirely forgotten that there were such things as towers on the Sussex Downs. A point of interest in connection with the main supply scheme for this part of England was, he added, that the line carrying the supply from Brighton to Worthing made use, for the first time in this country, of spun reinforced concrete towers. Later in his address Mr. Brydges reverted to some of the technical difficulties in the way of operating the "Grid" system. He foresaw difficulties in paralleling large generating stations, each operating with its own power factor, and he anticipated similar troubles with the smaller stations synchronising their plants with the "Grid" supply. The use of high voltages, he thought, might overcome some of those troubles, but there still remained the secondary "Grid" to contend with. In the long run, he visualised that unless some quite revolutionary change came along, the providing of cheaper electrical energy would remain in the hands of electricity supply authorities and their engineers.

One important piece of information given as an addition to the address was the news that as the result of combined action among electrical apparatus manufacturers a standard electric cooker has been evolved at a materially reduced price, and specimens were on view in the Exhibition, which has now become a feature of the I.M.E.A. Conventions.

The only paper read on the first day of the Convention, in addition to the presidential address, was by Alderman R. S. Chatfield—Chairman of the Eastbourne Electricity Committee—which, in the main, consisted of good advice to those just elected as members of Electricity Committees. In it he also urged the adoption, as a compulsory obligation on all Electricity Committees, of rental wiring schemes, whilst multi-part tariffs were also recommended. The author concluded with the remark that, unless members of Electricity Committees took a greater and more intelligent interest in the affairs of their undertakings than had often been the case in the past, then the question of the people's representation on Electricity Committees would become a farce.

It stands to Alderman Chatfield's credit that whilst the Eastbourne Standing Order regarding Chairmen of Committees is that no man shall occupy that position for more than two years, that Standing Order has been suspended in his case so that he can continue for a further twelve months, a sufficient testimonial to the work he has done. Perhaps a further testimony to his keenness is that, although only an engine driver, he has had built for himself a small chimneyless house in which he depends solely upon electricity for all his domestic services.

The reading of this paper provided what is commonly known as the committeeman's day of the Convention, and only one engineer took part in the discussion. In the main there was general agreement with the various points made by the author, and particularly is it to be noted what an enormous change of opinion has taken place in recent years on the question of allocation of profits. Not many years ago probably

the bulk of municipal committeemen were in favour of allocating profits to the relief of rates, but now the number is very few. Political circumstances, too, caused the author to advocate the policyof not making profits and of giving the benefit to the consumers in the way of reduced tariffs, for, he states, with a certain suspicion of bitterness, on any profits made they will have to pay 4s. 6d. in the £, and therefore why make profits for the sake of paying heavy income tax upon them ?

Those who differed from the author only did so because they would go further. For instance, in the matter of the chairmanship and vice-chairmanship of Electricity Committees, some speakers leaned towards a long period of tenure of office. Alderman Walker, now Chairman of the Manchester Electricity Committee, and also a member of the Central Electricity Board, made one of his usual able and amusing speeches in which he portrayed the difficulties often encountered by Chairmen of Electricity Committees in dealing with new members of their Committees, and, in the light of his experience, urged Alderman Chatfield to write "A Perfect and Complete Guide to Electricity Committeemen," a pamphlet on "How to Rule the Unruly," and another on "How to Explain the Obvious." These titles will be sufficiently self-explanatory of what was meant, and they certainly indicate the difficulties which municipal electrical engineers have to face with their committeemen, although even Alderman Walker was willing to admit that the position is rapidly improving.

Another difficulty which was mentioned in the paper was the control which the Finance Committees of municipalities have in the past been able to exercise over the functions of the Electricity Committees, which latter are chafing under this disadvantage. The position has recently been somewhat improved in favour of the Electricity Committees, but not to the full extent desired.

One other feature of the paper and discussion was that municipal electrical authorities should subscribe more liberally to the funds of such allied organisations as the Electrical Development Association, the Electrical Research Association, and the British Engineering Standards Association.

The one purely engineering paper of the Convention was read on Wednesday, May 28th, when Mr. G. H. Lake, Borough Electrical Engineer at Derby, gave an account of the development of pulverised fuel firing in relation to economic boiler-house operation, in which many references were made to the operating results at the already much described power station at Derby. This will be dealt with subsequently.

There are some forty exhibitors at the Exhibition this year, and a very complete show of electrical apparatus, mainly domestic, has been arranged.

(To be continued.)

The Institution of Water Engineers.

PRESIDENTIAL ADDRESS.*

SINCE the war there has been a great advance in town planning and housing. Town planning schemes, which were in the course of preparation during and since the war, have come into fruition, and building development has proceeded at a rapid rate. The building development on town planning lines, providing for arterial, secondary and estate roads and for erecting houses of all classes on sites restricted to a lesser density than that which was possible under the old by-laws as to new streets, and buildings causing thereby a spreading of the population upon a larger area, has brought about a new state of things in the matter of sanitation, water supply, &c.

In connection with the overcrowded courts and back-to-back dwellings, now happily cleared away, it was not uncommon to find that one tap supplied the water used for domestic purposes by the residents of half-a-dozen houses. The sanitary accommodation was almost as meagre, and fixed baths were non-existent. Now the houses of the poorer classes are provided with an ample and convenient water supply for domestic purposes, including baths. The houses of the middle classes are also better provided for in this respect, and the bathing habit has become more general.

All of these provisions for the improvement of the health of the community have cast new obligations and burdens upon Water Undertakings, and have made more pressing the necessity of preserving our rivers and streams from pollution.

The additional obligations and burdens on Water Undertakers, to which I have previously referred, have been brought about by highway and building development and the increase of vehicular traffic.

Schemes involving the stopping-up, diversion and widening of highways are not carried out without expense being cast upon Water Undertakers. The raising or lowering of the surface of the road and the widening and straightening of an old highway, have rendered it necessary to lay new mains, or to divert those existing. This infliction of additional expense upon Water Undertakers calls for an amendment of the highway law enabling compensation to be claimed when the mains, or access thereto, are prejudiced thereby. There is at the present time a movement on foot to compel Water Undertakers to lay at their own expense a main on each side of the street, also at their own expense to lay and thereafter to maintain so much of the communication or supply pipe to the premises as lies under the surface of the street. These propositions are in the interests of the highway authorities and the owners of property, and however desirable it may be that these changes take place, there should, in such event, be an amendment of the law providing for the readjustment of the financial burdens.

It is agreed that in a wide street it is to the advantage of the highway authority that there should be a service main on either side, thus avoiding the breaking up of the highway. It is an economy to the property owner that there should be duplicate mains, inasmuch as it is cheaper to lay the second main than the series of supply pipes crossing a wide street. The cost of the second main should, therefore, be borne by the property owners.

It is well known to engineers and managers of Water Undertakings that the supply of water to the dwellings occupied by the poorer classes is afforded at a loss. This is the case in respect of about 70 per cent. of the rated tenements in London, the deficiency being made up from higher rated properties, and from trade supplies, &c. In this connection I would point out that in one of the new estates near London, which is fully developed and where there is a population of about 100,000, the gross income from water rates equals only about 12½ per cent. on the cost of the mains. On such an estate it would probably require a gross income of from 40 to 50 per cent. on the cost of the mains to pay the cost incidental to affording the supply of water. It will thus be seen that building development of the type to which I have referred is not only a source of financial burden, but it increases the anxiety attached to the provision of the necessary water for their use.

In order to cope with the ever-growing demand for water, it is necessary to seek other sources of supply and to augment the storage reservoir capacity; to improve the efficiency of filtration plant and pumping machinery, and in other ways to lessen the cost of water supply and increase the quantity available. These are matters which continually engage the attention of the Water Engineer. He cannot afford to run obsolete and wasteful plant, and must exercise wise judgment in the selection of the type of machinery employed.

When selecting the type of pumping engines, regard will be had as to whether the engines are to run almost continuously or intermittently, or whether they are to act as stand-bys to other plant. In the event of engines being required to run 90 per cent. of their time, reciprocating engines will probably be found to be economical, even taking into consideration their higher initial cost, whereas the steam turbine operating centrifugal pumps will, on account of the lower capital cost, certainly be found to be advantageous as a stand-by.

In the matter of filtration, the Metropolitan Water Board have, during the past ten years, installed rapid primary filters on a large scale, thus enabling the secondary or slow sand beds to be speeded up to a rate of three or four times that at which they previously worked. The introduction of this system at the Board's works has saved large sums which would otherwise have had to be spent in constructing many acres of slow sand filter beds.

In the year 1921, the Board began the construction at the Barn Elms Works of their first installation of primary rapid filters of the open gravity type. The object in view was by pre-filtration to enable the adjacent slow sand beds to filter more rapidly. The "experiment," for such it was to the Board, at a cost of £49,000, proved to be a great success.

Filtration works similar to those at Barn Elms have been constructed at Walton and Kempton Park. At Barn Elms and Walton the primary filters almost adjoin the storage reservoirs from which they are fed; at Kempton Park they are situate at the end of a conduit conveying the water from the "Queen Mary" Reservoir at Littleton, about 2 miles distant.

The waters of the Rivers Thames and Lee in their raw or untreated state contain algal growths, and the fresh water mussels found therein are also a source of trouble. In dealing with waters containing algal growths, primary filtration is of very great value in preventing or delaying the clogging of the secondary beds. The appearance of algæ in the water is often so sudden as almost to paralyse the functions of the secondary beds when unaided by pre-filtration.

The position of the primary filters in relation to the storage reservoirs is a matter of considerable importance. Fresh water mussels (*Dreissensia polymorpha*), in shape and size when fully grown somewhat resembling a Brazil nut, attach themselves to the masonry, ironwork, &c., of the storage reservoirs and to the inside of the pipes leading thereform. They congregate in layers and clusters, but appear to be unable to exist in the outlet pipes leading from the reservoirs to the filter beds for a greater distance than about a mile to a mile and a half, probably because in that distance their food supply has become either exhausted by themselves or defunct from want of light. At the mouth of the pipe the layers may be several inches in thickness, tapering to nothing at a distance. I have, indeed, found the bore of a 36in. diameter pipe to be reduced to 12in.

Now, it is quite clear that the nearer the primary filters are to the raw water, the greater the benefit to be derived. There is less distance in which the mussels can congregate, and there will be fewer of them to remove from the pipe, and it is a serious thing to have to remove the mussels from a mile and a half of main, entailing not only expense, but suspending for several days or weeks the use of the main and works dependent thereon. Even if the secondary filters, by reason of the original planning of the works, are at some distance away from the primaries, it is better that the long conduit should contain pre-filtered water free from mussels and, at most seasons of the year, free, or nearly so, from algæ. At the filtration stations of the Metropolitan Water Board where, without pre-filtration, stored raw water is discharged direct to the slow sand filter beds, there is always a large quantity of mussels which have to be removed periodically.

In preparing a scheme for filtration works the primary filters should, if circumstances permit, be arranged at such a level that they may be charged from the adjacent storage reservoir without the necessity of pumping, and the secondary beds at such a level that the primarily filtered water may gravitate thereto. As an example in the saving of capital cost where primary and secondary filters are employed in combination, as against slow sand filters acting alone, the Walton Works may be cited, where the saving amounts to about £284,000.

A very pressing problem with which the Engineer has to deal is the deterioration of water mains by electrolysis and graphitic action. In this matter he should be in close co-operation with the chemist. I have recently prepared a report upon this subject and my investigations are being continued. The proper protection of the pipe against the action of soil and water is essential. Experiments also show considerable advantage in a good metallic contact of the pipes at their joints. This can be obtained by sand-blasting or otherwise cleaning the inside of the socket and outside of the spigot and then coating with lead spray or electrically deposited lead.

The conclusions arrived at from the various investigations and experiments may be condensed as follows :—

(1) Earthing connections from the casings of transformers dealing with electric currents of a pressure of 500 volts or more should be made by means of a proper and efficient earthplate as far removed as possible from any pipe or apparatus of the Undertaker, or that of any water consumer.

(2) Any telephone or bell return circuits of telephone exchanges which are not specially provided for by a return wire, should be connected to an earthplate as above.

(3) No earthing connection should be made to any pipe or apparatus of the Undertaker, or that of any water consumer, from any electrical installation other than such as may be required for conducting away temporary leakage of current from faulty fittings.

(4) Whenever earth connection is made on any premises in which is installed a water meter belonging to the Undertaker, it should be made on the inlet side of the meter, or a bond should be inserted across the meter.

(5) In the case of any wireless set supplied from the electric lighting system, the earthing connection should be made by means of an earthplate as far removed as possible from any pipe or apparatus of the Undertaker, or that of any consumer.

(6) In order to mitigate or obviate electrolytic corrosion either from stray currents or difference of potential between the metal or metals, it is essential that the joints between the several pipes or between the pipes, apparatus or fitting of the Undertaker or the consumer, should be electrically efficient, and that no jointing material having an insulating effect should be inserted at the joints. If jointing with insulating material is unavoidable, the pipes or fittings should be electrically bonded over the joint or joints.

(7) Although the "graphitic condition" which is found in so many pipes of the Undertaker and sometimes in only quite short lengths, may, in some measure be due to electrolytic action, it is probably, in a greater degree, due to the action of sulphur produced by bacterial action, or otherwise from the gypsum content of the yellow London clay, or from refuse, ashes, coal gas, and other materials containing sulphur.

(8) It would appear that the only method of eliminating this action is by keeping the clay or other sulphur-containing material away from possible contact with the pipes by surrounding them with a protecting medium.

(9) It would also appear desirable that in order to eliminate as far as possible electrolytic action due to stray currents or otherwise, the material surrounding the pipe should be as dry as possible.

To protect the interests of water undertakers it is necessary that by-laws or regulations should be made as to the earthing of electric currents.

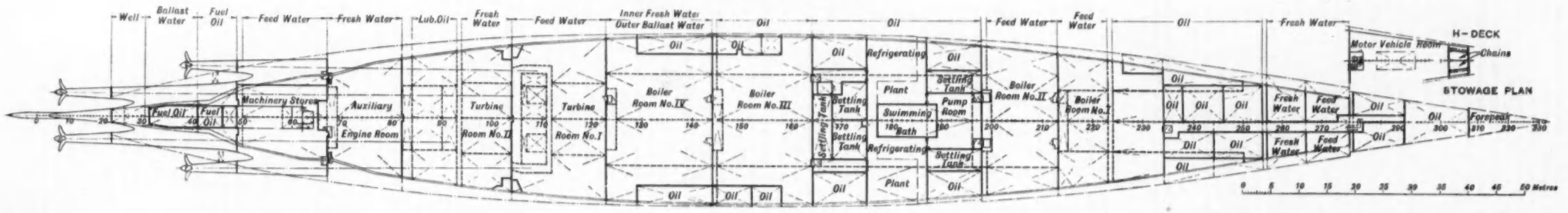
* Delivered by Mr. Henry E. Stilgoe, M. Inst. C.E., Chief Engineer, Metropolitan Water Board, on Wednesday, May 28th, 1930. Abridged.

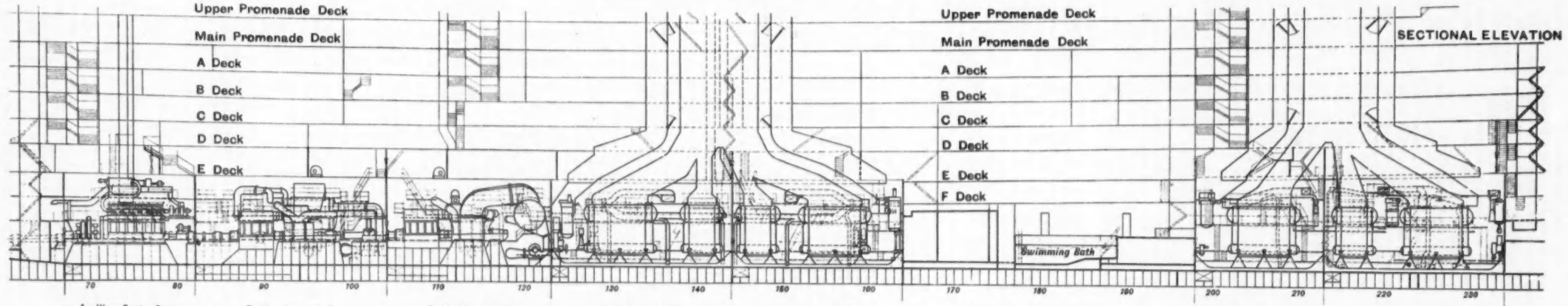
SIXTY YEARS AGO.

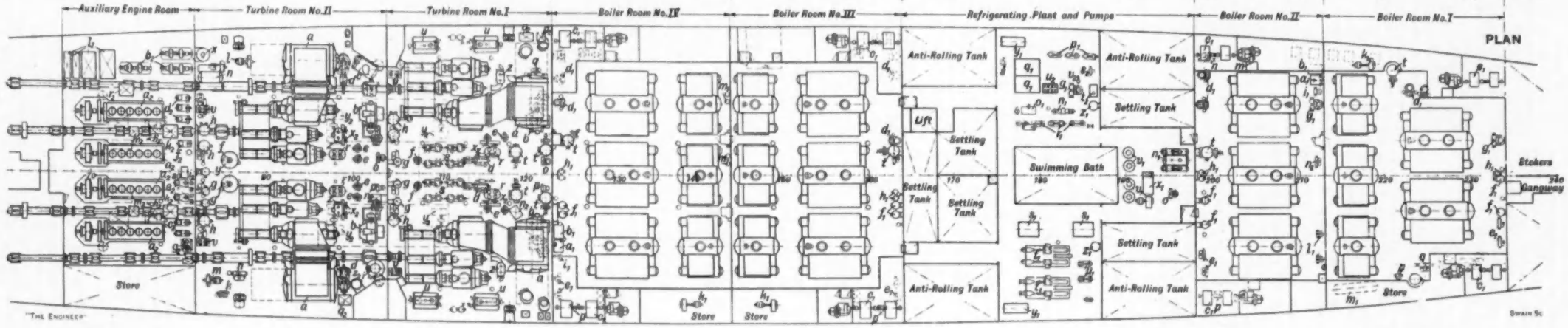
IN our issue of June 3rd, 1870, we returned with unabated vehemence to our criticism of Sir Joseph Whitworth and his system of ordnance. The personal side of the argument had recently been accentuated by the resignation of General Lefroy from the post of Director-General of Artillery. According to us General Lefroy's regrettable resignation was the outcome of the policy of change which had been in evidence at the War Office ever since the advent of Mr. Gladstone's Government. Sir Joseph Whitworth's friends, however, implied that General Lefroy had virtually been dismissed because he had shown himself unfitted to advise the War Office in artillery questions. He had, it seems from our account, refused to accept as conclusive, experimental evidence laid before him by Sir Joseph designed to establish the superiority of the Whitworth system of ordnance. Sir Joseph's experiments were conducted with a series of tubes of about the size and thickness of ¾in. gas barrel. The cylinders were composed of various metals, cast iron, wrought iron and the "miraculous and mysterious" Whitworth red and yellow metals, on the properties of which Sir Joseph based a considerable portion of his claims for the superiority of his artillery. The tubes, simple or compounded of two metals, were exploded and the charge required to burst them was taken as a measure of the suitability of their metals for the construction of guns. The lowest figure—20—was given by a plain cast iron tube, and the highest—325—by a plain tube of Whitworth yellow metal. We sought to show that the tests were in no way comparable with tests on full-sized guns and that they were self-evidently ridiculous, in that they implied the possession by the Whitworth yellow metal of a tensile strength of 113½ tons per square inch. General Lefroy had also regarded the tests as anomalous and untrustworthy, and had urged Sir Joseph to carry out experiments of a similar kind with thick, instead of thin, cylinders. Sir Joseph prepared such a cylinder in his yellow metal and tested it in the Director-General's presence. General Lefroy was, however, still unconvinced, and in an unguarded moment expressed his sense of the untrustworthiness of the test by saying that it was not impossible that a cylinder of good cast iron would have behaved equally well. Sir Joseph seized his opportunity, constructed a corresponding cylinder of cast iron and blew it to pieces with 3 oz. of gunpowder. His own metal had withstood the explosion of 1½ lb. of gunpowder without bursting. General Lefroy's resignation speedily followed, but we continued our opposition to Sir Joseph. The cast iron cylinder, we suggested, had been made under Sir Joseph's own supervision and had been loaded in a manner eminently suited to make it burst with the least possible charge. Such was the atmosphere in which scientific controversy was conducted sixty years ago.

MACHINERY LAY-OUT OF THE NORTH GERMAN LLOYD LINER "BREMEN"

(For description see opposite page.).



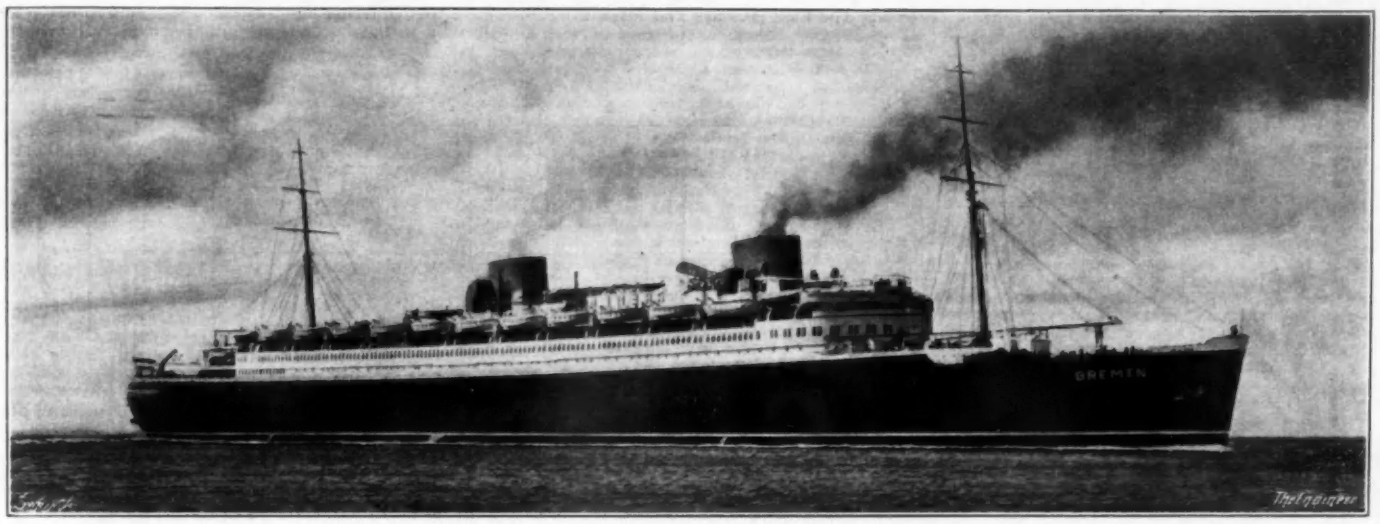




- *a* Main Condensers.
- *b* Main Circulating Pumps.
- *c* Auxiliary Condensers.
- *d* Steam Ejector Air Pumps.
- *e* Condensate and Drain Pumps.
- *f* Main Lubricating Oil Pumps.
- *g* Lubricating Oil Filter.
- *h* Lubricating Oil Cooler.
- *i* Bilge Water Oil Separator.
- *k* Fire Extinguishing Plant.
- *l* Bath Pumps.
- *m* Sanitary Pumps.
- *n* Deck Washing Pumps.
- *o* Fresh Water Pumps.
- *p* Bilge Pumps.
- *q* Ballast Pumps.
- *r* Drain Tanks from Turbines.
- *s* Main Feed Pumps.
- *t* Feed Heaters.
- *u* Evaporator.
- *v* Lubricating Oil Separators.
- *w* Hot Sea Water Installation.
- *x* Drain Tanks for Water-tight Door Installation.
- *y* Water Pressure Tank for Water-tight Door Installation.
- *z* Manœuvring Valve.
- a_1 Float Tanks.
- b_1 Cascade Tanks.
- c_1 Boiler Draught Fans.
- d_1 Auxiliary Feed Pumps.
- e_1 Service Pumps.
- f_1 Oil Transfer Pumps.
- g_1 Oil Heater.
- h_1 Pressure Filter.
- i_1 Drain Pumps.
- k_1 Air Fans for Harbour Use.
- l_1 Evaporator Feed Pump.
- m_1 Compressed Air Vessel for Soot Blowers.
- n_1 Lathe.
- o_1 Work Bench.
- p_1 Brine Pumps.
- q_1 Brine Cooler.
- r_1 Swimming Bath Pumps.
- s_1 Refrigerating Plant Condenser.
- t_1 Refrigerating Machines.
- u_1 Refrigerating Cooling Water Pumps.
- v_1 Fresh Water Filter.
- w_1 Hot Fresh Water Installation.
- x_1 Swimming Bath Aeration Plant.
- y_1 Drain Tank for Cold Stores.
- z_1 Receptacle for Rubbish.
- a_2 Oil Engine-driven Generator Sets.
- b_2 Converter Sets.
- c_2 Auxiliary Air Compressor.
- d_2 Circulating Water Pumps.
- e_2 Fuel Supply Pumps.
- f_2 Auxiliary Lubricating Oil Pumps.
- g_2 Lubricating Oil Separator.
- h_2 Ventilating Fans.
- i_2 Starting Receivers.
- k_2 Lubricating Oil Collecting Tank.
- l_2 Lubricating Oil Tank.
- m_2 Drain Oil Tank.
- n_2 Telephone Boxes.
- o_2 Lubricating Oil Tanks.
- p_2 Cylinder Oil Tanks.
- q_2 Oil Tank for Bilge Water Oil Separator
- r_2 Engineers' Lift.
- s_2 Steam Brine Pumps.
- t_2 Salt Dissolving and Heating Tank.
- u_2 Mud Collector for Brine Pipes.
- v_2 Brine Filter.
- w_2 Mud Pump.
- x_2 Starting and Manœuvring Platforms.
- y_2 Engine-room Ventilating Fans.
- z_2 Cloth Filter for Bilge Water Oil Separator.

THE NORTH GERMAN LLOYD LINER "BREMEN"

'DEUTSCHEN SCHIFF UND MACHINENBAU A.G. BREMEN, BUILDERS AND ENGINEERS



The Propelling Machinery of the North German Lloyd Liner Bremen.

No. I.

ALTHOUGH some brief particulars concerning the design of the hull and propelling machinery of the new North German Lloyd liner "Bremen" were published on the occasion of her launch and about the time of her successful maiden voyage in July, 1929, and special reference to her lifeboat equipment and propelling machinery was made in the papers read by Director P. Biedermann and Dr. Gustav Bauer before the Schiffbautechnischen Gesellschaft in Berlin in 1928 and 1929,* the first complete technical account of this noteworthy Atlantic liner is that which was published on Saturday, May 24th, in the special "Bremen" issue of the *Zeitschrift des Vereines Deutscher Ingenieure*. The shipbuilding aspects of the design and the equipment of the new liner are ably dealt with by Dip.-Ing. P. Biedermann, director of the Norddeutscher Lloyd, and Dip.-Ing. H. Hein, director of the Deutschen Schiff und Maschinenbau A.G. Werk A.G. "Weser," of Bremen, who built and engined the ship. The main and auxiliary propelling machinery is described in some detail by Dip.-Ing. W. Koch, director of the Norddeutscher Lloyd, who was directly responsible for that part of the vessel.

The general appearance of the "Bremen" is clearly shown in the above illustration, and in what follows we propose to refer at first to some outstanding points in the design of the hull, passing later to a more detailed description of the turbines, boilers, and auxiliary machinery.

The main dimensions and particulars of the liner are enumerated in the following table :—

Hull Particulars.

Overall length	286·1 m.
Length between perpendiculars	270·7 m.
Breadth moulded	31 m.
Depth to D deck	13·9 m.
Maximum draught at sea	10·326 m.
Gross tonnage	51,656
Designed service speed	26·25 knots
Designed maximum speed	27·0 knots

Passenger Accommodation.

First-class passengers	800
Second-class passengers	500
Tourist-class passengers	300
Third-class passengers	600
Officers and crew	1000

Main Propelling Machinery.

Type : Quadruple-screw single-reduction geared turbines	
Designed output	92,500 S.H.P.
Designed astern output	65 per cent. of ahead
Turbine speed	1800 r.p.m.
Propeller speed	180 r.p.m.
Diameter of Propellers	5000 mm.
Four blades with pitch	5200 mm.
Weight of each propeller	About 17 tons

Boiler Installation.

Number of water-tube boilers	Twenty
Designed working pressure	23 atm. (327 lb. abs.)
Superheated steam temperature at turbine	350 deg. Cent.
Number of double-ended boilers	Eleven
Heating surface each boiler	1100 square metres
Number of single-ended boilers	Nine
Heating surface each boiler	550 square metres
Total heating surface	17,050 square metres
Total superheater surface	3875 square metres
Total air heater surface	8786 square metres

* See Jahrbuch der Schiffbautechnischen Gesellschaft, 1929 and 1930.

Auxiliary Generator Sets.

Number of auxiliary oil-electric generator sets	Four
Designed output each 230-volt set	520 kW
Output of engine	780 B.H.P.
Number of cylinders	Six
Designed running speed	260 r.p.m.
Number of emergency dynamos	Two
Total output at 115 volts	200 kW
Designed running speed	375 r.p.m.

Some particular characteristics of the hull, which are illustrated in the photographs we reproduce on this page, include the sloping stem, which has a bulbous form below the water line at the turn of the stem and runs to a fine knife edge about the water line, slightly broadening out towards the top. The stern is of a modified cruiser form and it incorporates an Oertz rudder. A peculiarity of the outside plating

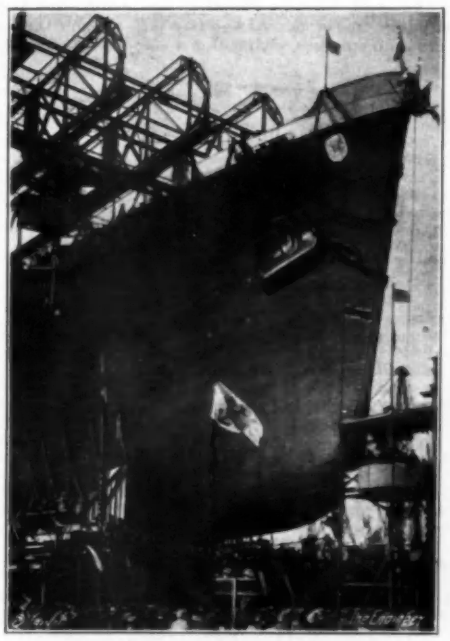


FIG. 1—BOW OF THE "BREMEN"

is the arrangement whereby the joints of the plates are made with the sharp edges forward, which is indicated in Fig. 1. In order to save weight, countersunk riveting was employed, which also gives a more pleasing appearance to the skin of the ship. From the towing trials a trim position corresponding to a draught of 9·75 m. with a load of 9200 tons, distributed as shown in the stowage plan, was decided upon, which from actual service results was confirmed to be most satisfactory. In order to conform with the latest requirements of the London Conference on Subdivision, the hull was divided into fourteen watertight compartments, reaching up to D deck, corresponding in depth to a draught of 10·326 m. By providing collision bulkheads between the two turbine rooms, as shown on page 608, the safety of the ship was further ensured, in that in the case of a possible collision one engine-room would probably remain intact, while the turbines could at least be manœuvred from that engine-room. A feature of the hull design, which follows closely that embodied in the later pre-war German liners, is the adoption of divided boiler uptakes, an arrangement which enables a central lay-out of public rooms to be adopted. In the case of the "Bremen," this feature is helped, too, by the wide spacing of the two funnels.

For the general construction of the hull a mild steel with a breaking strength of 41 kilos. to 50 kilos. per square millimetre, or about 26·0 to 31·7 tons per square inch, was used, according to Germanischer Lloyd rules. The same classification society also allowed a special steel of higher ultimate strength, namely, 52 kilos. to 60 kilos. per square millimetre, or about 33·0 to 38·1 tons per square inch, with an elongation of 20 per cent., to be used for certain important parts of the ship and superstructure. These plates were heat-treated after rolling and were drilled and carefully handled in the yard. About 7000 tons of this special steel was built into the ship, giving a saving in weight of about 800 tons by reason of the lighter scantlings. Special construction was necessary in the carrying out of the design of the larger public rooms and the superstructure, while between the funnels on the sports deck a special aeroplane launching catapult on a turntable was provided for.

Space will not allow us to describe in detail the excellent arrangements of the cabins and public rooms in all classes. The ventilation, lighting, sanitary and fire protection arrangements have been carried out according to the latest practice, and they incorporate many new and pleasing features. The pantries and kitchens are well planned and there are large refrigerator rooms available for ship's use.

The steering gear is steam engine-driven, as are also the capstans and anchor winches. The navigating apparatus includes an Anschütz gyroscopic compass, with an automatic helmsman and a course recorder. Submarine signalling apparatus, echo-sounding gear, a depth recorder and log, also fire detecting and extinguishing installations and the watertight door controls are grouped on the bridge and in the chart house. The directional wireless equipment is of the very latest type. The lifeboats include 22 motor lifeboats, each designed to carry 145 persons, four motor lifeboats, each for 35 persons, and two ordinary lifeboats for 40 persons. The lifeboats are nested in davits of the McLachlan-Welin type, with automatic boat-lowering gear.

In order not to impede the speed of the ship, the ordinary bilge keels were omitted and in their stead Frahm anti-rolling tanks are incorporated in the design. These tanks are shown on page 608, and are arranged between the boiler-rooms. A complete description of the principle of the Frahm anti-rolling tank will be found in the issues of THE ENGINEER for April 18th and 25th last.

THE PROPELLING MACHINERY.

The preliminary designs for the propelling machinery were first considered in October, 1926, when a twin-screw installation embodying geared turbines, oil-fired boilers, modern feed heating practice, steam-operated steering gear and refrigerating plant, and Diesel-electric auxiliary machinery, was discussed with the prospective builders. The contract speed then fixed upon was 24 knots. When, however, in November of the same year the contract speed was increased to 26·5 knots, a quadruple-screw arrangement was decided upon, and, on grounds of smaller space and reserve steaming power, water-tube boilers were preferred. The final design was accepted in January, 1927, shortly after the Vulcan yard and the Weser yard had amalgamated to form the "Deschimag." A trial boiler was built and tested on the Norddeutscher steamer "Roland" with very satisfactory results, and as a result of these tests a working pressure of 23 atmospheres with high superheat was finally chosen. The question of air supply to the boilers was closely studied, and it was

decided to adopt a closed stokehold with special regulated draught by fitting valves connecting the air ducts with the mantle around the funnel casings. The arrangement finally adopted is clearly indicated in Fig. 3.

With regard to the design of the main turbines and boilers and the material for the same, special consideration was given to these important items, and also to the problem of steam pipe joints and heat insulation. For the boiler water drums it was at first proposed to utilise the new Krupp Izett steel, but owing to the small supplies of this material then available, which were not considered adequate for the two sister ships "Bremen" and "Europa," a steel of 47 kilos. to 54 kilos. per square millimetre, or 30 to 34 tons per square inch, with a minimum extension of 20 per cent., was adopted for the drums, and a 41 kilos. to 48 kilos. per square millimetre, or 26 to 30·5 tons per square inch, with an elongation of 20 to 25 per cent., was chosen for the other parts of the boiler. The question of boiler tubes and their expansion was carefully investigated, and for insulating purposes the 85 per cent. original Newalls magnesia covering was accepted, with spun-glass mats with asbestos coverings for boiler work. The feed-water problem was solved by providing adequate distilling plant and large reserves of boiler feed in special tanks. With regard to the materials for the main turbines, cast steel was largely utilised in the construction of the turbine casings and for the blading Monel metal and V 5 M steel were decided upon; whilst "Admiro" bronze is used for the labyrinth packing rings of the main turbines.

The general lay-out of the machinery installation is clearly indicated in the two plans and the elevation drawing reproduced on page 608. The whole of the machinery is accommodated on the tank top in eight water-tight compartments arranged between frames Nos. 67 and 234. Between the frames Nos. 123 and 234 there are four groups of boilers, twenty in all, and between the boiler-rooms there is the refrigerating plant and the pump rooms. The space between the frames Nos. 104 and 123 is taken up by the two out-board turbines, while aft of this engine-room, between frames Nos. 82 to 104, the two in-board turbines are arranged, each turbine group having its own auxiliaries and controls. Still further aft of this engine-room there is the Diesel generator and switchboard room, which extends between frames Nos. 67 and 82. The four shaft tunnels are carried aft to frames Nos. 22 and 49, where they terminate in an outlet. The legend beneath the blocks on page 608 give details of the different units in these engine and boiler rooms.

Each turbine group comprises a high-pressure or intermediate-pressure and low-pressure turbine, driving double pinions which engage with the double main gear wheels on the propeller shaft. The steam has a pressure of 23 atmospheres or 327 lb. abs. with a superheated temperature of 350 deg. Cent. The astern turbines, which have a designed output of 65 per cent. of the full ahead power, are arranged in the casings of the intermediate-pressure and the low-pressure turbines, which contain the high and low-pressure astern turbines respectively. Means are provided for the inspection of the turbine blading, and manholes give access to the blades and blade-fastening screws. In the main the turbine casings are covered with Newalls magnesia insulating material, but asbestos matting is provided at points which may require more frequent inspection and attention. The nozzle boxes for the high-pressure ahead and astern turbines are made in cast steel, and special arrangements are provided to facilitate the easy inspection and draining of the outside stuffing-boxes. The high-pressure and intermediate-pressure turbines have balancing pistons of the labyrinth type. All the completed turbine rotors were carefully balanced dynamically.

Adjustable flexible couplings of the double-claw type are interposed between the turbines and the pinions, and the claw couplings are made from non-corrodible material. At the free end of each turbine there is an emergency shut-down valve which operates

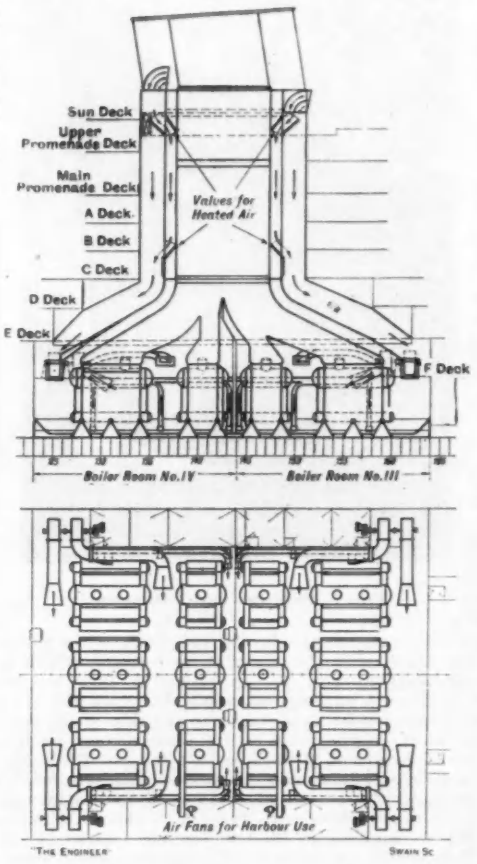


FIG. 3—BOILER UPTAKES AND FUNNEL

when the speed of the turbine rises to 10 per cent. higher than the designed maximum speed. The same device also cuts off the supply of steam should the supply of lubricating oil to the turbine or gearing bearings, or when the rotor, from any cause, gets out of true axial alignment. The superheated steam from the boilers passes first through a water separator and the quick-closing valve to the main ahead and astern manœuvring valves. It next passes through the wheels for the ahead and astern running at the same time. From the high-pressure turbine the steam passes to the intermediate-pressure turbine and leaving this turbine is conducted through two pipe connections to the low-pressure ahead turbine. The outlet from the low-pressure turbine is connected to the surface condenser.

Drain pockets are provided to collect water thrown down in the turbine casings, and these are connected with the drain system and drain tanks. Special arrangements are made for warming up the turbines prior to starting up. Overhead cranes and pulley blocks are installed for lifting the turbines in case of inspection and overhaul. The high-pressure turbine drive is at the top of the main wheel and the low-pressure and intermediate-pressure drives are arranged at about the wheel centre on either side. As previously mentioned, the main gear wheels are double. The thrust bearings are of a modified Michell pad type, and the tunnel shafts, which are constructed in sections, have ring-lubricated bearings. They are specially large in diameter in order to avoid torsional oscillation. The propellers are of the four-bladed solid type. Their principal dimensions are given in the above table. The four propellers and the spares were supplied, partly by J. Stone and Co., Ltd., of Deptford, and the Manganese Bronze Company, Ltd., and partly by a Bremen firm of propeller makers.

THE BOILER INSTALLATION.

When at sea the "Bremen" requires for the main and auxiliary machinery and for ship's use no less than about 500 tons of steam per hour. Particulars of the boilers are given in the accompanying table, and in Fig. 2 we reproduce a sectional drawing of one of the double-ended boilers. The large size of the steam drum, nearly 5ft. 7in. in diameter, may be remarked upon. This drum is furnished with two domes, there being one dome only in the case of the single-ended boilers. The two lower drums are of smaller diameter, about 33½in., and they are connected by tubes which are so arranged that the superheater elements can be accommodated in between them. There is an outside riveted casing and the air heaters are arranged at the top of the boiler at either side.

The superheater elements consist of bundles of fourteen coils, of which there are four in the double ended and two in the single-ended boilers. The steel tubes are sprayed with aluminium and are mounted in frames which can be easily withdrawn for inspection. As the drawing indicates, a large number of removable inspection doors are provided. The combustion chamber is lined with refractory material. Soot blowers are fitted for the cleaning of the generating tubes, the superheater tubes and the air heaters. The boilers are robustly constructed and stiffened, and they are mounted on a cast steel base. The weight of a double-ended boiler is about 90 tons, and the completed boilers were dispatched from the makers' works on skids and were lifted into the partly completed hull by the overhead yard cranes. The boiler fittings include high-lift Cockburn safety valves and Mumford feed regulators. The regulators are

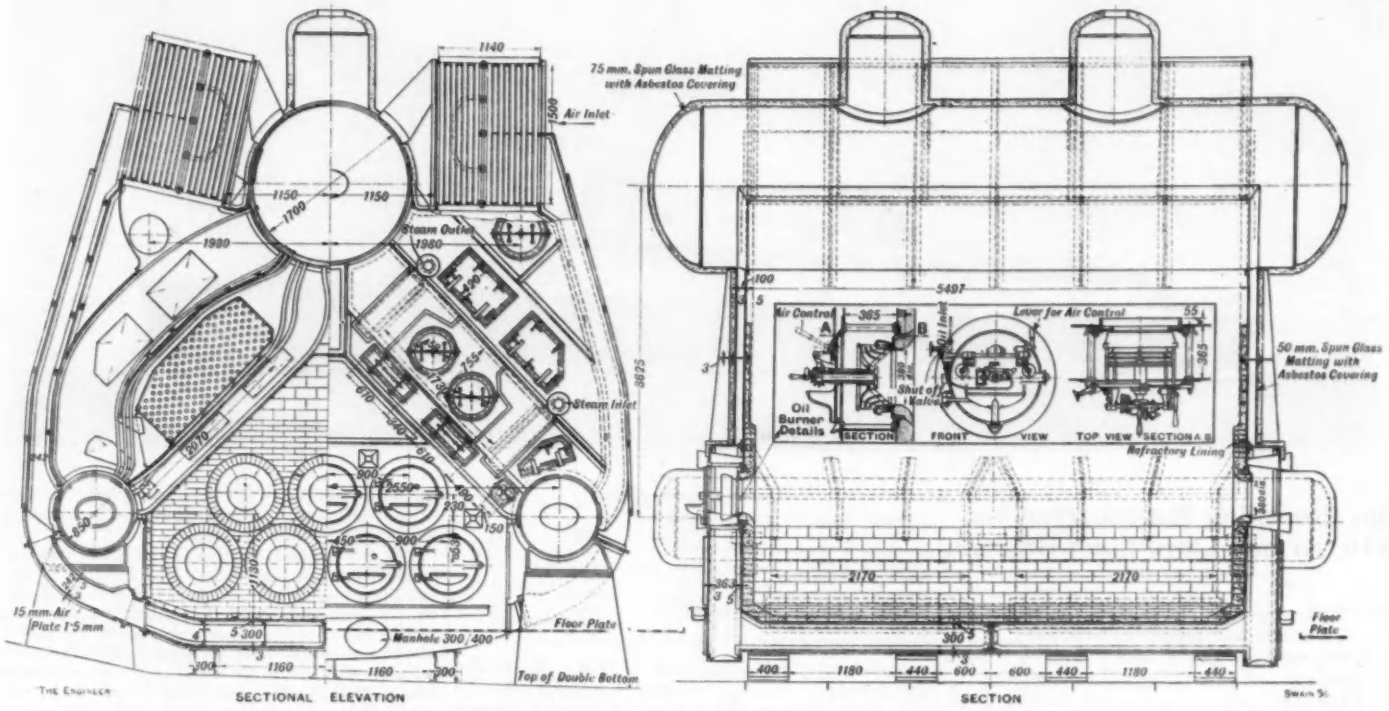


FIG. 2—SECTIONAL VIEWS OF A DOUBLE-ENDED BOILER

so attached to the steam drum that by shutting a valve they can be inspected with the boiler in operation. In the steam domes a dryer of the Tangential type is fitted.

The arrangement of the boiler uptakes and the furnace with the mixing valves for hot and cold air is indicated in Fig. 3. Altogether some 1600 tons of oil fuel is carried in the double bottom and the side bunkers. The oil from the bunkers is pumped to settling or ready-use tanks for daily use, and these are shown in the drawings we reproduce.

In our second article we shall deal more particularly with the auxiliary machinery and special appliances.

(To be continued.)

Physical Research and Wireless.*

THE Institute of Physics was incorporated in 1920 in order to form into a professional body all physicists interested in industrial applications. Trained physicists had provided so many ingenious and useful weapons of attack and defence during the war that there was every anticipation of their future importance in British industry during peace. Until nearly the end of the war physicists who were occasionally called upon to enter the service of the State were officially classed as "chemists," as the word "physicist" had not appeared in the official vocabulary, and those who had entered industry did so in the guise of "engineers." The need for a professional Institute of Physics was evident. The stability which the Institute has attained after a life of ten years shows that its founding was justifiable.

The purpose of this presidential address is to show that the physicist has already proved his value in industry, and the subject of wireless telegraphy and telephony has been chosen for the address as an illustration of the constructive work of the physicists in a typical modern enterprise. In preparing an account of the contributions of physicists to wireless I shall omit all reference to the great engineers who have adorned the industry, as otherwise my address would be a complete history. With this intention of making a case for the physicist I may begin by pointing out that Hertz's experimental demonstration in 1888 of the physical existence of electric waves was the foundation of wireless. But Hertz's apparatus was insensitive, and, therefore, the detectors discovered by Lodge, Branly and Minchin in 1889 and 1890 were an essential to any prospective practical application. After these purely scientific investigations had provided the means and materials, wireless telegraphy was born at the British Association meeting at Oxford in 1894, when Lodge sent morse signals from a spark apparatus worked by a telegraph key and recorded them on a moving paper tape by receiving apparatus at a distance. Later, in 1897, Lodge's laboratory produced the method of tuning aerials by inductance coils thus enabling each transmitting station to correspond with a selected receiving station tuned to it. Another laboratory product was the arc generator of continuous waves—due to Duddell and Poulsen. It led the way to wireless telephony, which was developed rapidly by Fessenden, a professor of physics, until, in 1907 the human voice was heard across the Atlantic. This ranks as the greatest achievement of wireless up to that date, for telephony was then impossible on long cables.

In 1913 the amplifying valve came to maturity. It was purely the work of physicists, the use of a grid being traceable to the experiments of a German physicist in 1902. The coming of the valve brought two consequences; firstly, the scrapping of the great spark stations, which had been laboriously developed during fifteen years of pioneer engineering work, and, secondly, after the war, the popularisation of wireless telephony in the form known as broadcasting. Many other less impressive technical developments and improvements can similarly be attributed to the introduction by the physicist, from time to time, of new principles and ideas into the technique of wireless.

At the present moment the industrialists of this country are indulging in profound self-examination and there is much discussion of the process called rationalisation, which was brought into prominence in 1927 by the World Economic Conference at Geneva. The main object of rationalisation is to reduce the costs of production and operation in important industries, and its aspects are multitudinous. But, keeping to the technological side, an important instrument of rationalisation is standardisation, and another is the modernisation of plant and products by the introduction of the latest invention and knowledge. Now there is a certain amount of contradiction here, for standardisation is opposed to modification, and the conflict has, so far as I know, not yet been thoroughly discussed. To put the matter another way, it is not economic to standardise machinery or products too soon; that is, before the latest improvements have been incorporated, and, on the other hand, it is not economic to modify a standardised form until the costs of adopting it have been recovered. This conflict is well illustrated in the history of wireless and unceasingly appears in many industries, such as the electrical industry, and, therefore, the physicist is deeply concerned in it. To those responsible for making decisions, it is no easy task to settle when to introduce improvements and when to stop improving in order to standardise. They probably regard the physicist as the villain of the piece, for he has been, in certain industries, the cause of many a sudden change of direction, the source of many a revolutionary idea. But the better view of the position of the physicist in this matter is that he possesses potentialities for helping as well as for disturbing the stability desirable even in progressive motion. Being intimately connected with the laboratories whence spring the sort of invention that shatters the established technique, he is better equipped than others to forecast in some degree the direction of forthcoming change and to assist in deciding the instant and mode for standardising and for modifying.

* Institute of Physics. Presidential address by Dr. W. H. Eccles, F.R.S.—Abstract.

Canadian Engineering News.

(From our own Correspondent.)

Business Outlook.

ACTIVITIES in the basic industries in the Dominion have shown definite signs of improvement during the first four months of 1930, following a period of depression in the closing months of 1929. The downward movement in steel production and automobile output has been reversed, and construction activity has shown a marked increase. Trade in general is in fair volume. Interest generally centres in the announcement of the complete reorganisation of Nova Scotia's great steel and coal industry, the British Empire Steel Corporation, Ltd., the Dominion Steel Corporation, Ltd., and the Dominion Iron and Steel Company, Ltd., having merged into a single unit. The reorganisation plan is one of the largest in scope ever undertaken by a Canadian corporation. Under the plan the ownership of these companies and their numerous subsidiaries, situated mainly in the province of Nova Scotia, will pass to the Dominion Steel and Coal Corporation, which was incorporated for the purpose by Act of the Nova Scotia Legislature in 1928. The scheme has for its main object the placing on a sound footing the financial structure of one of the largest industrial organisations in the Dominion.

Aviation Expansion.

Canada is on the threshold of important developments in connection with aviation. More than 7,000,000 dollars will be spent on the improvement of airways this year by the Dominion Government, while a large amount will be spent by the provinces of Ontario and Quebec, which have their own air forces for forest fire prevention and other work. Private companies which carry passengers and mails and engage in exploration and mining development also have ambitious programmes. The University of Toronto, and the McGill University at Montreal are contemplating the establishment of courses in aeronautical engineering, and interest in aviation generally is being stimulated by twenty-three aeroplane clubs throughout the Dominion and by the Aviation League of Canada. The Dominion Government is concentrating this year upon the consolidation of existing airways, the improvement of lighting and weather reporting systems and the introduction of radio beacons on all night-flying routes. Aeroplanes now fly daily with mails from Halifax, Saint John and Moncton, on the Atlantic Coast, to Montreal. Other routes have been established in the West. More than 4,000,000 dollars will be spent by the Dominion this year in connection with aerial photographic surveys, forestry patrols, suppression of forestry and grain pests, establishing aerodromes and airship bases. About 3000 miles of air routes are now being operated or organised in the Dominion.

Beauharnois Lets Big Contract.

The order for the first 200,000 horse-power generator installation at the plant of the Beauharnois Power Corporation, on the St. Lawrence River, has been given to the Canadian General Electric Company. The order consists of two 25-cycle, 50,000 H.P. generators, two 60-cycle, 50,000 H.P. units, and a further two 8000 H.P. units, which will supply power for plant purposes. The machines are to be delivered by the spring of 1932, and they will go into operation by October of the same year. Thereafter further units will be added rapidly to bring the plant up to its initial 500,000 H.P. capacity.

To Deepen Channel.

The United States and Canadian Governments have entered into an agreement for the deepening and improvement of the St. Lawrence channel between Kingston and Ogdensburg, at a cost of 1,500,000 dollars. At the present time the main channel between Lake Ontario and Prescott, on the Canadian side, and Ogdensburg, on the American side of the St. Lawrence, is not deep enough to accommodate the large grain vessels which will proceed down from the upper lakes with the opening of the new Welland Ship Canal on July 1st. The Canadian Government is building a large terminal elevator at Prescott, at a cost of several million dollars, to accommodate the export grain business which will follow the opening of the new canal.

The largest part of the work to be done in American waters is the widening of the channel from 350ft. to 450ft. The channel takes a circuitous course through the Thousand Islands, touching both Canadian and American waters. When completed the channel will have a minimum depth of from 25ft. to 27ft., and a minimum width of 450ft., which will accommodate with safety the largest boats now on the Great Lakes. From Brockville to Prescott, the river is fairly free from obstructions with a channel about 1000ft. wide. In the stretch from Kingston to Brockville there are about twenty-five shoals, which will have to be eradicated.

New Industry Predicted.

Lignite in the province of Saskatchewan has been definitely placed in the commercial coal class as the result of recent tests to demonstrate the utility of the fuel in competition with imported coals. The tests were conducted under the direction of Hon. J. A. Merkley, Minister of Railways, Labour and Industries in the Saskatchewan Government. Boiler tests were conducted at the Canadian National Railway shops in Regina. They were carried out continuously for twenty-four hours, and it was established that the lignite, under proper conditions of combustion, would give satisfactory thermal and boiler efficiency.

New Power Plant in North.

Northern Ontario, including mining districts and the James Bay slope, where is situated the new lignite coalfield, will be well supplied with hydro-electric power with the coming into operation of a new development, the construction of which is announced to take place immediately. The situation of the new project is on the Abitibi River, 65 miles north of Cochrane, Ontario. The water passing through the Abitibi canyon and rapids above is to be harnessed to develop 275,000 horse-power in a project costing—for the dam, power-house, machinery, &c.—a total of 23,000,000 dollars. An additional 3,500,000 dollars will be spent on a transmission line to Sudbury, where power is urgently required for mining operations. The new development will be carried out by the Hudson's Bay Power Company, a subsidiary of the Abitibi Power and Paper Company. A contract has been entered into between the Hydro-electric Power Commission of Ontario and the Hudson's Bay Power Company for the delivery of 100,000 horse-power to the Commission. The transmission line will be built at the expense of the Hydro Commission.

Canada Leads in Newsprint Exports.

Of world newsprint exports in 1929 amounting to 3,851,000 tons, Canada exported 2,511,000 tons, or 65 per cent. The leading part which Canada plays in the production of this important commodity is shown by its position at the head of a list of twenty-four producing countries with an output of 2,729,000 tons, or very nearly double the amount shown by its nearest competitor, the United States, which had an output in 1929 of 1,392,000 tons. The total production of newsprint paper in twenty-four countries last year was 7,308,000 tons. Canada's share amounted to 37·3 per cent., as against 19·0 per cent. for the United States. Canada's total was 78,000 tons larger than the combined output of the United States, Great Britain and Germany, the next three countries in point of volume of production.

INSTITUTION OF NAVAL ARCHITECTS.

THE Summer Meeting of the Institution of Naval Architects will be held at Liverpool from July 14th to 18th next. The following provisional programme has been prepared:—On Monday evening, July 14th, there will be an informal reception in the Midland Adelphi Hotel on the invitation of the Chairman of the Liverpool Executive Committee, Sir Frederick C. Bowring, J.P. On the Tuesday morning, the Lord Mayor of Liverpool—Councillor Lawrence D. Holt, J.P.—will welcome members of the Institution in the Council Chamber of the Town Hall, and thereafter papers will be read and discussed. In the afternoon alternative visits will be paid (*a*) to the docks and River Mersey on the steam yacht "Galatea" and the tender "Skirmisher." The ss. "Duchess of Bedford"—Canadian Pacific Steamships, Ltd.—and the m.v. "Ulster Monarch"—Ulster Imperial Line—will also be visited; (*b*) to the works of the British Insulated Cable Company at Prescot, or the works of Messrs. Bryant and May at Garston. In the evening there will be a reception and dance at the Town Hall on the invitation of the Lord Mayor of Liverpool.

On the Wednesday morning visits will be paid to the Cathedral; the P.P. Press, colour printers, and the works of the new Mersey Tunnel, now in construction. Members can also visit the Walker Art Gallery; St. George's Hall; the Museum, which contains a special exhibit of ship models, and the Engineering Laboratories of the University. The Lord Mayor will entertain foreign visitors to luncheon in the Town Hall. In the afternoon alternative visits will be paid to (*c*) Messrs. Lever Bros., Port Sunlight, and to the Lady Lever Memorial Art Gallery; and (*d*) to the Metropolitan Vickers Electrical Company, Ltd., at Trafford Park. The Institution dinner will be held at the Midland Adelphi Hotel in the evening.

On the Thursday morning, further papers will be read and discussed in the Central Technical School. In the afternoon luncheon will be taken (*a*) on board ss. "Franconia" on the invitation of the Cunard Steam Ship Company, or, alternatively, at the invitation of Cammell, Laird and Co., Ltd., followed by an inspection of the shipyard and engine works. In the evening, there will be dinners and dances on board (1) ss. "Patroclus," of the Blue Funnel Line, berthed in the Birkenhead Docks; (2) m.v. "Aba," or "Adda," of the Elder Dempster Line, berthed at the South end of the docks, and (3) ss. "City of Hong Kong," of the Hall Line, berthed in the Birkenhead Docks.

On the Friday, there is to be an all-day excursion to North Wales by charabanc. Alternatively, members may visit Chester.

INSTITUTION OF MECHANICAL ENGINEERS.

GLASGOW AND WEST OF SCOTLAND BRANCH.

THE Chairman and Committee of the Glasgow and West of Scotland Branch of the Institution of Mechanical Engineers have arranged a series of works visits to take place during the summer months, and the following fixtures have been made:—June 6th and 7th, Local Summer Meeting; June 26th, the Albion Motor Car Company, Ltd., Scotstoun; September 11th, Babcock and Wilcox, Ltd., Renfrew.

For the Local Summer Meeting, by permission of Balfour Beatty and Co., Ltd., and the British Aluminium Company, Ltd., a visit has been arranged for Friday and Saturday, June 6th and 7th, to the Grampian Hydro-Electric Scheme at Rannoch and the Lochaber Hydro-Electric Scheme at Fort William. The following is an itinerary of the Meeting:—Friday, 5.50 a.m.: Leave Queen-street Station by Fort William train, arriving at Rannoch Station at 8.40 a.m. Conveyances will await train to take party to the Central Camp of the Grampian Scheme, where the power-house, pipe line, surge chamber, tunnel and head waters will be inspected. The party will proceed to Fort William and spend the night there. On the Saturday, the power-house, pipe line, surge chamber and valves of the Lochaber Scheme will be inspected. A return to Glasgow will be made at night.

The University of Manchester.

LAST week the University of Manchester celebrated the fiftieth year of its existence and the eightieth anniversary of Owens College. The proceedings started with a Congregation of the University at which the Chancellor conferred degrees—*honoris causa*—upon a number of persons eminent in law, letters, science and music, including Brigadier-General Dawes and Mr. Philip Snowden. The history of this University really dates back to 1851, when the Owens College—its precursor—was founded by John Owens, who bequeathed at his death a sum of nearly £100,000 for "providing or aiding the means of instructing young persons in such branches of learning and science as are usually taught in English universities," subject to the condition that neither students, professors, nor teachers should be required to make any declaration of their religious opinions. The new College was started in a house which was formerly the home of Richard Cobden. This house soon proved too small, and it was enlarged by the erection of a chemical laboratory in which Dr. Edward Frankland and Sir Henry Roscoe worked and taught. Altogether, the staff comprised five professors—all leaders in their respective spheres—but in spite of their excellence the College had a great struggle for existence, through which it emerged successfully. The enlarged house then proved too small and an appeal in 1868 resulted in a sum of £100,000 being obtained, with which the larger portion of the present site was purchased, and in 1873 the main block of buildings and the chemical laboratories were opened. A Royal Charter was obtained in 1872, but the professors, including Roscoe, decided to press for the powers of an independent university with the power of granting its own degrees. Supported by the Corporation of Manchester, a memorial for a University Charter was presented to the Privy Council, but was opposed by the Yorkshire College, Leeds. This caused a modification in the application, which resulted in the establishment of the Victoria University, with its seat in Manchester, in 1880. Under the new scheme the Yorkshire College, Leeds, and the University College, Liverpool, became associated in the University, an arrangement that had disadvantages, and in 1903 the Victoria University of Manchester was established.

The Court of Governors is a large body, including among its *ex-officio* members the Lord Mayor of Manchester, the Chairman of the Lancashire County Council, and representatives of several County and Borough Councils. The Department of Engineering was started chiefly by two large legacies bequeathed by Mr. Charles Clifton and Mr. C. F. Beyer, of the firm of Beyer, Peacock and Co., and these legacies were utilised to endow the Professorship of Engineering, which was first held by Osborne Reynolds, the value of whose work, both in reasearch and in teaching, has only within recent years begun to be fully appreciated. Chairs in Electrical Engineering and Metallurgy have also been established. In addition to Engineering, the Faculty of Commerce and Administration has become one of great importance to a vast community which is chiefly engaged in industry, including the inhabitants of towns as far off as Blackburn, Burnley, Chorley, Warrington, Oldham, and Bolton, from which the University receives encouraging support.

In his address of welcome to the Congregation on Friday last, Lord Crawford and Balcarres, Chancellor, acknowledged the University's indebtedness to all the local public authorities for their support. He said that they intended to use all the forces at their command for the improvement of education as such, as well as to build up the personality and the character of all those brought within the University's sphere of influence.

Books of Reference.

The South African Mining and Engineering Year Book and Directory, 1930. Published by South African Newspapers, Ltd. London: 72-78, Fleet-street, E.C. 4. Price £1 1s.—This year's issue of this useful book of reference contains, first of all, an alphabetical list of the principal firms in the engineering, electrical, iron, steel, machinery, hardware and allied trades throughout the Union of South Africa, Northern and Southern Rhodesia, &c. Then follow:—(*a*) A list of Mines in Rhodesia, South-West Africa, and Tanganyika Territory; (*b*) a list of Overseas Manufacturers represented in South Africa and Rhodesia; (*c*) a Buyers' Guide to Mining and Engineering Specialities; (*d*) a list of British and Overseas Manufacturers and Exporters to South Africa; and (*e*) a series of portraits of mining, industrial, and financial leaders. Then comes a series of articles on "The Witwatersrand Industry in 1929"; "The Great National Industry of Gold Mining"; "The Rand's Native Labour Supply"; "The Diamond Industry in 1929"; "Platinum in 1929"; "The South African Coal Industry in 1929"; "Asbestos in 1929"; "The Tin Industry in 1929"; and "Base Metals and Minerals in Southern Africa." Following these there is an electrical section which deals with Power Supply; Telephony; and the Victoria Falls and Transvaal Power Company, Ltd.; and at the end of which there is a list of South African Electric Supply Undertakings. Next there is an engineering section in which illustrated reference is made to a number of engineering firms and other enterprises, which is followed by articles on "Auxiliary Ventilation for Mines"; "Making Steel Tubes at Vereeniging"; "Reinforced Concrete Pipe Progress"; "Mozambique"; "The Mining Industry in Southern Rhodesia"; "Railway Progress in Rhodesia"; "The Geology of Southern and Northern Rhodesia"; "The Copper Fields of Northern Rhodesia"; "L'Union Minière du Haut Katanga"; and "The Bulawayo Engineering Works." Then there are sections devoted to Diamonds, Asbestos, Collieries, the Base Metals, Platinum, &c. Finally, a large portion of the volume is taken up with particulars of numerous mining undertakings of various kinds. Altogether, the book contains a vast amount of information, and to add to its value there are maps of the Witwatersrand; the South African Collieries; Northern and Southern Rhodesia; and the Northern Rhodesia Copper Fields.

Rhodesian Mining and Engineering Year Book, 1930. Published by South African Newspapers, Ltd., London, 72–78, Fleet-street, E.C. 4. Price 12s. 6d.—This is a book of reference very much on the lines of the "South African Mining and Engineering Year Book," and it contains much the same sort of information. Among its contents are to be found lists of (*a*) the principal engineering concerns in Rhodesia; (*b*) Consulting Engineers and Geologists; (*c*) of mining and municipal railway and industrial buyers, with the names of the concerns for which they buy. Then particulars are given of the Departments of Mines; the Rhodesia Chamber of Mines (Bulawayo); the Chamber of Mines (Salisbury); Mining, Industrial, and Financial Companies; Mines in Northern and Southern Rhodesia, South-West Africa, and Tanganyika Territory; and Overseas Manufacturers represented in Rhodesia and the Union. A feature of the book is the illustrated references to numerous mining concerns in Northern and Southern Rhodesia. There are also maps of Northern and Southern Rhodesia; the Northern Rhodesia copperfields; the Witwatersrand, and the South African Collieries.

The Railway Year Book for 1930. London: Published by the Railway Publishing Company, Ltd., 33, Tothill-street, Westminster, S.W. 1. Price 5s. net.—In the present volume—the thirty-third annual edition—all the information has, we are told, been systematically revised. Among innovations it may be mentioned that full details are given of the extensive Southern Railway reorganisation which came into force on April 1st this year. New maps of the London, Midland and Scottish and Southern Railway systems, revised to the end of 1929, as well as a new map of the Midland and Great Northern Joint Railway are included, and several others of the maps have been corrected in minor respects. A new table is that which gives the longest railway station platforms, and the section on the "Largest Railway Stations in Great Britain" has been revised in view of the fact that besides Victoria (L.B.S.C. and S.E.C. Sections), the two London Bridge stations, and also Victoria and Exchange stations in Manchester, are now operated as one station each. The "Railway Year Book," is, in fact, a very handy work of reference, and very frequently information is to be found in it which is either unobtainable or only to be acquired with difficulty elsewhere.

The Universal Directory of Railway Officials, 1930. London: The Directory Publishing Company, Ltd., 33, Tothill-street, Westminster, S.W. 1. Price 20s. net.—This invaluable book of reference appears this year in its thirty-sixth annual edition. It is too well known now to need introduction, but it may well claim to be unique in that no other publication contains a complete list of all the chief Railway Officials all over the world. It is divided into eleven sections, as follows:—Official, Great Britain, Ireland, Europe, Asia, Africa, Australasia, North America, Central America, Mexico and the West Indies, South America, and a Personal Index of Railway Officials. The present issue, we are told, has been very thoroughly checked, and is claimed to have been brought thoroughly up to date. As far as we have checked it, we have found that claim to be justified. Indeed, we may say of it that very rarely in the past have we found it inaccurate, or have we failed to find in it the information for which we sought.

Chemical Engineering and Chemical Catalogue. Sixth edition. 1930. London: Published by Leonard Hill, Ltd., 231–32, Strand, W.C. 2. Price 15s.—We have had occasion to speak highly of previous issues of this excellent book of reference, and we have nothing but good to say of the present issue. It has become too well known by now to need any detailed reference to its contents, but we may say that it quite lives up to its publisher's description of it, namely, that it is "a work of technical reference for all production industries, and a catalogue of heavy and fine chemicals, raw material, machinery, plant, and equipment applicable to production industries, standardised, condensed, and cross-indexed." There are several alterations, additions and improvements in this year's book, as compared with those which have gone before it. For example, the division of the different sections is now shown by means of thumb indentations instead of protruding tabs; the Data and Tables section has been doubled, many of the tables having been specially compiled and being now published for the first time; and the technical books section has been revised, while selected books published during the year have been included. The index to suppliers has been completely revised, which has necessitated, so we gather, ten thousand or more alterations. Furthermore, to increase the foreign circulation of the book and to those speaking other languages, the main index, which is the key to the volume, has been set in Spanish as well as English.

Kelly's Directory of Merchants, Manufacturers and Shippers of the World, 1930. In two volumes. London: Published by Kelly's Directories, Ltd., 186, Strand, W.C. 2. Price 64s.—This year's issue is the forty-fourth edition of this exceedingly useful book of reference, and it is so well known that lengthy introduction from us would be entirely superfluous. The publishers point out that, in addition to comprising more than one and a-half million names and dealing with over 20,000 places, the work is, actually, a gazetteer, and contains a fund of facts and figures of the utmost value to the business man, no matter in what class of merchandise he may be interested. It is, as all the commercial world knows, divided into two volumes, the first of which deals with foreign countries and their possessions, while Volume II. is concerned with Great Britain, India, and the British Dominions, Colonies, Protectorates and Dependencies. That part of Vol. II. which deals with Great Britain is subdivided into the following sections:—1. England, Scotland and Wales; 2. London; and 3. Ireland. Each of these sections is again divided into the following sub-sections:—(*a*) Alphabetical; (*b*) classified trades; (*c*) telegraphic addresses; (*d*) exporters; and (*e*) importers. The whole has, we understand, been corrected with scrupulous care and brought thoroughly up to date. It is a book in which one can with the greatest ease obtain the information sought for, and we ourselves have it constantly in use.

Chamber of Shipping of the United Kingdom, 1929–1930, *Annual Report*. London: Published by the Chamber, 28, St. Mary Axe, E.C. 3.—This book, while it mainly relates to subjects directly or indirectly affecting the shipping industry, contains much that is of interest to a wider public and is most useful for reference purposes. As giving some idea of the scope of this year's volume, we may say that it deals with such subjects as "The Economic Position of Shipping: Freights, Shipping Earnings and Idle Tonnage," "Causes of the Depression: Too Little Trade, Too Much Tonnage, Influence of Subsidies, High Costs, &c.," "Progress of Trade Restoration at Home and Abroad," "Safety of Life at Sea," "National Affairs," "Imperial Affairs," "International Questions," &c. Over one hundred pages are devoted to statistical tables and diagrams concerned with all manner of useful and interesting data and information. Then, too, there is a reprint of the presidential address, which was delivered at the annual meeting of the Chamber by Sir Arthur Sutherland, Bart.

BRITISH WATERWORKS ASSOCIATION.

AT the invitation of the Lord Mayor, Aldermen, and Councillors of the City of Liverpool, the nineteenth Annual General Meeting of the British Waterworks Association will be held this year at Liverpool, from Wednesday, July 9th, 1930, to Friday, July 11th, 1930.

The following order of proceedings has been arranged:—On Tuesday afternoon, July 8th, at 5 p.m., there will be a meeting of the Executive Committee of the Association at the Adelphi Hotel. On the Wednesday, at 11 a.m., the Conference will be opened in the Central Technical School. After the transaction of the usual business, the President for the ensuing year will be elected and deliver an address. Then, after further business has been dealt with, the following papers will be read and discussed, the proceedings being continued throughout the afternoon:—(*a*) "The Value of Frequent Tests in the Bacteriological Examination of Water, and their Bearing on the Interpretation of Results," by Professor J. M. Beattie, Bacteriologist to the City of Liverpool; (*b*) "The Afforestation of Catchment Areas," by Mr. R. L. Robinson, Forestry Commissioner; and (*c*) "Standard Charges for Water Supply and Revised Accountancy System in Waterworks Undertakings," by Mr. H. O. Stafford Cooke, Barrister-at-Law, Secretary to the Portsmouth Water Company. "The Report of the Advisory Committee of the Ministry of Health on Compensation Water" will also be discussed. In the evening at 7 p.m. there is to be a receipton at the Adelphi Hotel, by the President, Alderman Edwin Thompson and Mrs. Edwin Thompson, which will be followed at 7.30 p.m. by the annual dinner.

On the Thursday morning there are to be alternative visits to (*a*) the Mersey Tunnel Works; (*b*) the Gladstone System of Docks, by invitation of the Mersey Docks and Harbour Board, on Steamer "Galatea"; and (*c*) Liverpool Cathedral; while in the afternoon there will be alternative visits to (*d*) the Cunard Liner "Laconia," by invitation of the Cunard Steamship Company, and (*e*) the New Power Station at Clarence Dock. In the evening at 9 p.m. there will be a reception at the Town Hall by the Lord Mayor and Lady Mayoress of Liverpool.

On the Friday there is to be an all-day excursion to Oswestry and Lake Vyrnwy, while on the Saturday optional visits may be paid to places of local interest.

B.E.S.A. SPECIFICATIONS.

ELECTRIC MOTORS AND GENERATORS FOR MINES AND MINERS' HANDLAMP BULBS.

IN continuance of the programme of work in the Colliery Section, the British Engineering Standards Associaton has just issued British Standard Specifications for Electric Motors and Generators for Mines and for Miners' Handlamp Bulbs.

The Specification for Electric Motors and Generators for use in Mines applies to machines of 1 brake horse-power and upwards per 1000 r.p.m. having windings insulated with Class A material and wound for voltages not exceeding 7000 volts. The Specification has been drawn up to comply with the General Electric Regulations made under the Coal Mines Act, and in its preparation due regard has been paid to the explanatory notes made in Mines and Quarries, Form No. 11. The Specification does not apply to turbo-type machines, rotary converters, motors for traction purposes, *i.e.*, motors mounted on vehicles for their propulsion, nor does it apply to motors embodied in coal cutters, drills and conveyors, for which another specification will be prepared. Two classes of machines are provided for by the specification, those for use in locations where flameproofness is not required, and those for use in locations where General Regulations 127 (v.) and 132 of the Coal Mines Act are applicable.

The Miners' Handlamp Bulbs Specification provides for the ordinary class of 2-volt bulb with a nominal rating of 2 watts, used underground in collieries. The terms of the specification have been determined after a series of tests which are probably unique. Batches of lamps were manufactured under normal conditions, having filaments designed to operate at different efficiencies. All these lamps were carefully measured and a proportion of each design tested, in the manner defined in the specification, at several test stations, including those at the National Physical Laboratory, and the Mines Department, Sheffield. Lamps of each design were also sent to six coal mines, chosen to represent the widely varying conditions normal to the industry, and details of their performance were carefully logged. The data so obtained from both laboratory tests and experience in the mines, have been used in framing the specification.

Copies of these Specifications, Nos. 270 and 377, can be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. each, post free.

HIGH-POWER MERCURY ARC RECTIFIERS

BROWN, BOVERI AND COMPANY, ENGINEERS

FIG. 1—400-kW RECTIFIER AT WYCOMBE

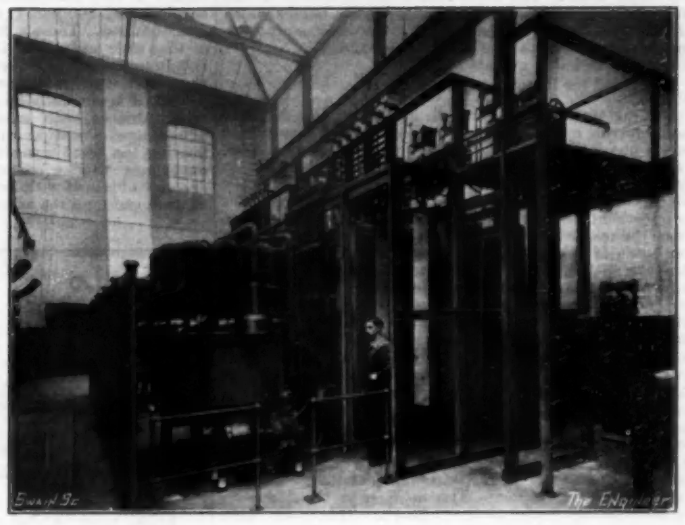


FIG. 2—3000-kW RECTIFIERS AT MARYLEBONE

High Power Mercury Arc Rectifiers.

Two examples of high-power rectifiers recently built and installed in this country by Brown, Boveri and Co. are shown in the accompanying illustrations. The rectifier shown in Fig. 1 has been supplied to the Wycombe (Borough) Electric Light and Power Company, one of the companies associated with Edmundson's Electricity Corporation. The plant is rated at 400 kilowatts, and delivers direct current at 420 volts to the lighting and power network, whilst the three-phase 50-cycle supply feeds the transformer at a pressure of 5300 volts. Although the plant is designed for manual operation, it is left unattended. The plant is one of four supplied to Edmundson's Electricity Corporation, and another plant for that concern is at present under construction. The other illustration—Fig. 2—shows the largest rectifier units installed in this country. They have been erected in the Blandford-street sub-station of the St. Marylebone Borough Council, and each set is rated at 3000 kilowatts, with a pressure range of 490–530 volts on the direct current side, the pressure of the incoming three-phase, 50-cycle supply being 6600/6900 volts.

Regulation of the direct-current pressure is obtained by means of tappings on the high-tension side of the transformer windings, which are provided with "on load" tap-changing switches, with twenty steps. These step switches are mounted inside the transformer tanks, whilst the "spark" switches with the discharge resistances are placed on top of the insulators outside the tank. The step switches for each phase are mechanically coupled, and are either operated by hand at the transformers or by remote control gear from the switchboard. Some idea of the dimensions can be formed by comparing the height of the attendant with the height of the rectifiers and transformers on the right. For its output the plant is claimed to occupy very little space. A closed circuit cooler is employed for dealing with the cooling water of these rectifiers, but as it has been erected in an elevated position in an adjoining room, it does not occupy any floor space. If tap water were used this cooling plant would, of course, be unnecessary, but an objection which some engineers have to the use of tap water is that the supply is liable to be interrupted, and in the absence of a storage tank the plant may be put out of operation.

Since the metal-cased rectifier was first introduced considerable improvements have been made in its design and construction, and plant of this kind is now said to be thoroughly reliable and exceptionally simple to operate. The steel-cased rectifier is made up of a number of parts, all of which must be capable of being easily dismantled, and when assembled must be able to maintain a very high degree of vacuum within the working chamber. The various parts must therefore be separately sealed, and in the high-power rectifier the sealing medium is mercury, which permits of vacua as high as 0·005–0·0001 mm. H G to be maintained without difficulty. An advantage of the mercury seal is that leakage quickly shows itself in the gauge by a slow sinking of the mercury, and by the tightening of a nut or two the leakage is usually stopped. Considerable alterations have been made within recent times to the internal parts of metal-cased rectifiers. The complete rectifier now stands upon insulators, mounted directly on the floor, as shown in Fig. 1, instead of on a foundation ring as employed in the past. Moreover, whilst in the early rectifiers the ignition and excitation circuits were separate and the ignition necessitated the provision of a small motor generator set, the two circuits are now interconnected and the arc is automatically started by alternating current. The complete operation of putting a modern high-power rectifier into service from the moment of closing the primary oil switch can be carried out in two or three seconds.

For the purpose of exhausting the rectifiers and maintaining the high degree of vacuum for the successful operation of the plant, small vacuum pump sets having a high extraction capacity are employed. The set consists of a preliminary vacuum pump with its valve controlled by oil under pressure, and a high vacuum mercury vapour pump. The preliminary vacuum pump is driven by a ¼ horse-power slow-speed motor, and is of the oil-immersed pattern. The duty of this pump is to discharge the mixture of gas and air extracted from the rectifier by the high vacuum pump to the atmosphere.

To enable the vacuum to be ascertained a special form of hot wire gauge is now used in conjunction with a direct reading instrument. The operation of the gauge depends upon the variation in the thermal conductivity of gases with the pressure. The gauge consists of four platinum wires, two of which are exposed to the vacuum and two to the atmosphere. The former are contained in a glass tube in the form of the letter H, fitted in the vacuum piping system. The four ends of the platinum wires are connected to form a Wheatstone bridge, which is supplied with a constant current. A millivolt meter is used to register the variations in the voltage across the bridge, resulting from variations in vacuum, and is calibrated to indicate the vacuum directly. In the case of automatic plants this instrument effects the starting and stopping the vacuum pump. The millivoltmeter is of the contact pattern, but the control circuit is not broken within the instrument, and arcing at the contact is avoided. The current is interrupted in the automatic apparatus, and the contacts in the instrument merely close the circuit.

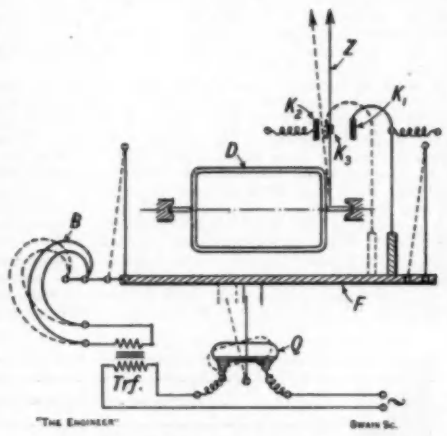


FIG. 3—VACUUM INDICATING APPARATUS

Below the moving coil of the millivoltmeter there is a sliding carriage, as shown at F in Fig. 3, and which, owing to the heating and cooling of the bi-metallic strips, slides backwards and forwards. This movement causes the contact K_1 to press against the contact K_2 on the pointer Z, which is pressed in turn against the contact K_3, and through these contacts the circuit of the auxiliary supply to the automatic gear is completed. Below the carriage a small mercury switch Q is pivoted, and is tilted by the movement of the carriage, so that the current flowing through the bi-metallic elements is interrupted. The elements therefore cool down again, and the carriage returns to its former position, and so opens the contacts. The process is repeated about every thirty seconds. The contact K_2 consists of a circular strip covering the full working range of the pointer, whereas K_1 is composed of a series of three or four contacts for good, insufficient, and bad vacuum. The pointer Z is free to move between the contacts, and it always takes up a position corresponding to the vacuum. In many manually-operated plants the vacuum plant is arranged for automatic control, thereby ensuring that the rectifier is always in a proper condition to take the load, because the pump is started up and shut down automatically, according to the pressure inside the rectifier.

Mainly on account of the small number of operations necessary, the automatic control of high-power rectifiers is claimed by Brown, Boveri and Co. to be much more simple than that of rotating machinery. The rectifier does not, for instance, need to be synchronised, and the question of polarity does not enter into consideration.

South African Engineering Notes.

Union Harbours Extensions.

THE reconstruction work at the Cape Town Docks, which was started in 1927, is proceeding steadily and fairly rapidly. The principal work is the construction of a new basin 196 acres in extent, enclosed on the south and east sides by a new random block mole, on the north side by the existing South Arm, and on the west by reclaimed ground terminating in wharves. The existing South Arm is being widened so as to increase the shed accommodation and railway facilities, and the south side of the South Arm will form four deep-water berths in the new basin. It is anticipated that these works will be completed, ready for use, in about twelve months' time. The entrance to the new basin will be 350ft. wide, as compared with an entrance width of 250ft. to the present main—the Victoria—basin, which has an area of only 67 acres. The deepening of the new basin will necessitate the removal of approximately 1,750,000 cubic yards of material. Provision is made for nineteen 4-ton cranes on the north wall of the South Arm, of which seven are in use, four are in course of erection, and the remainder will be erected by the end of this year. In addition, five 4-ton cranes and one 15-ton crane are on order for the new berths on the south side of the South Arm. The position as regards the 60-ton floating crane, which was reported to have been ordered, is not clear, but it should be ready by the end of the year. The absence of a crane capable of dealing with heavy lifts has led, in numerous instances, to cargo for Cape Town having to be taken to other South African ports where the necessary facilities exist and then sent back to Cape Town by rail, thus incurring extra expense and delay. Work on the breakwater extension is progressing satisfactorily, and it is anticipated that the whole of the harbour improvement works now in progress will be completed in 1933. The aggregate cost of the work will amount to between four and five million sterling. At Port Elizabeth several new harbour works have been authorised. They consist of the closing up of the most southern of the jetties, the Dom Pedro jetty, and the construction of an up-to-date wharf between the Dom Pedro and South jetties, which wharf will be equipped with the latest type of cargo sheds, electric cranes and other facilities for quick handling and despatch. It is understood that the work will cost in the vicinity of £400,000, which amount will be in addition to the sum of over a million and a-half sanctioned for the building of the breakwater and reclamation operations between the Baakens River and the railway terminus.

Some Rand Features.

Among the interesting facts collected for the benefit of the delegates to the Empire Mining Congress at Johannesburg were the following:—The largest ventilating fan in the world is installed on the Rand. It is a 30ft. Walker fan at the Government Areas, which is capable of exhausting 900,000 cubic feet of air per minute. The largest air compressor in the world is to be found at the Rosherville station of the Victoria Falls Power Company, its capacity being 80,000 cubic feet of free air per minute. There are seven other turbine-driven air compressors at Rosherville, making up a total compressing capacity of 300,000 cubic feet per minute. The world's biggest hoist is to be found at the City Deep and the world's largest gold refinery is the Rand refinery at Germiston. Since operations began at the refinery in December, 1921, bullion valued at more than £300,000,000 has been refined.

Rhodesian Iron Ore.

The report of the Director of the Geological Survey of Southern Rhodesia, in the course of a review of the Que Que area, draws attention to a deposit of high-grade iron ore, which might if developed turn out to be one of the largest in the whole world. After describing the general geological features of the portion of the Que Que gold belt, the report proceeds: South-westwards of these rocks, and dipping steeply beneath them, is a belt, 1½ miles wide, composed of basaltic greenstone with quartzite. Beyond this again is a triangular stretch of country formed of volcanic rocks of a more acid nature, associated with

numerous agglomerates and graywackes. The hills, which for lack of a better name may be termed the Lime Works Range, rising to a height of 400ft. above the general level, overlook this country on the western side. These hills contain a deposit of high-grade iron ore, which, if it is ever fully developed, may prove to be one of the largest in the whole world. The limestone, which is burned at the lime works, is enclosed on two sides by the banded iron-stone, folded back upon itself. The limestone has not been proved to continue as a bed along the range.

Demand for Motor Lorries.

Motor omnibuses are in increasing demand, and motor lorries even more so. The number of new motor lorries put into service during last year was about 4000. As to omnibuses, they are being ordered a score at a time by the large municipalities. The Johannesburg City Council is just now augmenting its fleet of fifty vehicles by a further fifteen at a cost of £25,000. It is believed that when the maize crop has been gathered, and transport to the coast is required, private road motor services will compete with the railways for it on a huge scale. The same thing is anticipated with regard to the next wool clip. The Departmental Railway Tariffs Inquiry Commission has just issued a report in which it states that it views with grave misgiving the potential danger to the railway through road motor competition, and expresses the opinion that a mass of road enterprise is only being held back at the present moment to see whether Parliament is going to pass legislation to regulate road motor transport, and to allow the railway administration to protect its very short distance traffic by reviewing the present regulations against the administration employing road motor vehicles where such are more economical than combined road and rail transport. The menace to the railway's maize-carrying traffic is very grave. This year there is expected to be a crop of 24,500,000 bags of 200 lb. each, of which about 11,000,000 to 12,000,000 will have to be transported to the ports for shipment, being the surplus over the country's needs. Last season the motor lorry made a comparatively slight inroad, carrying in all less than 15,000 tons, but the owners have found by experience that where the railways often took five days to get maize from Free State districts to the coast, the motor lorries were able to do it in two, and often less, from the same district. The motor lorries also found it easy to secure a return load at once, and so there was no time lost, as is often the case with railway trucks.

New Motor Ship Service.

The great volume of imports and exports to and from South Africa is calling for continual increases in the number of vessels engaged in transporting the merchandise, and continental lines are as alive to the importance of the Union's trade with overseas as any of the British lines. During the last few months new services have been put on by American, French, and Italian shipping companies, while the German lines have increased the number of their ships on this route. Now the Swedish South Africa Line has initiated a new service, whereby fast vessels will load monthly at coast ports and proceed direct to Scandinavian ports in from twenty to twenty-one days from Cape Town. The first of the company's boats, the motor ship "Hammaren," arrived at Cape Town a short time ago, and she will soon be followed by a sister ship. Although the "Hammaren" took twenty-two days on the voyage from Oslo, she is an unusually fast vessel to be designed essentially as a cargo carrier, and on her trial runs attained a mean speed on a measured mile of 15·5 knots, with a maximum speed of 15·9 knots. The vessel was built by Gotaverken, of Gothenburg, and is owned by the Rederiaktiebogalet Transatlantic, of Gothenburg. The principal dimensions are :—Length overall, 362ft.; breadth, 60ft.; moulded depth, 25ft. 6in. The propelling machinery consists of two four-stroke Diesel engines of the Gotaverken-B. & W. type, of 3500 I.H.P. The vessel is of 5800 tons deadweight, and is therefore not large, but is well adapted for her service; 778 tons of fuel oil are carried, which is sufficient for the round voyage. All deck auxiliaries are electrically driven, and the galley is oil fired. Very superior accommodation is provided for a few passengers.

Long Distance Gas Transmission in Germany.

By Dr. POTT, Dipl.-Ing.

A LITTLE over three years ago a plan was formed by the colliery and coke oven undertakings in the Rhineland and in Westphalia to utilise for industrial heating purposes the very large quantities of coke oven gas generated in the district and to transmit it by high-pressure pipe lines to considerable distances from the generating source. In order to increase the amount of gas available for such a scheme it was decided to limit the gas used for heating purposes at the mines and coke oven plants themselves, and to substitute for this gas not easily disposable coals and coke for boiler firing and for furnace heating, gas generated from coke breeze or blast-furnace gas where such was available. The following account of this scheme by Dr. Pott, the managing director of the Ruhrgas A.G., will be of interest to our readers.

To carry out the scheme the Ruhrgas A.G. was formed, and on the technical side advantage was taken of the experience already available in the United States with the transmission of natural gas over long distances in high-pressure pipe lines of welded steel. On the business and financial side the good results obtained from the gas distribution network begun in 1909 to 1910 in the Hamborn and surrounding districts proved of value. At the time the scheme was planned two sets of circumstances were particularly advantageous in helping forward a system of energy supply, then new in Europe. They were, first, the fact that the mining and coke oven industry of the Rhineland and Westphalia had under construction at that time a large number of centrally-situated coke oven plants of the most modern type, which rendered it easy to take steps to combine the whole output of gas; secondly, as nearly all the new coke oven plants were of the under-fired compound type, they were suited for firing with either producer or blast-furnace gas. By this means a very substantial increase in the amount of surplus gas, compared with that previously available, was obtained. These advantages on the mining side were at that time and still at the present are well supported by the desire for increased economy and thermal efficiency in the plants of the industries utilising the coke oven gas.

Thus it is now fully appreciated that the firing of industrial furnaces with coke oven gas offers considerable advantages compared with the old-fashioned method of heating the same furnaces with either coal, coke or producer gas. Higher efficiencies compared with other fuels are now obtained with pressure gas, and the total absence of dust, soot and the ash-handling problem have tended to extend the use of coke oven gas, particularly in those industries devoted to the working of coal, iron and steel and the production of by-products. In this way many new factories have been connected to the distribution pipe lines and the network has been widely expanded, with attendant economical results.

In order to preserve some kind of unity in the, at first, slowly increasing number of pipe lines, it became necessary for the Ruhrgas A.G. to give special attention to the layout and arrangement of the existing pipe lines with the object of bringing them within the scope of a wider plan. At the time the larger network was first proposed the principal pipe lines then existing were those of the Thyssen gas and waterworks in Hamborn and the gas distribution network of the Rhineland-Westphalian Electricity Works, or R.W.E. As the Hamborn pipe lines were in the hands of the Thyssen family, it was possible to make suitable arrangements whereby certain districts were served by that particular undertaking, while others were reserved for both the Thyssen and R.W.E. concerns, which worked together and delivered gas according to a pre-arranged plan of distribution. At a later date the R.W.E. network was taken over by the Ruhrgas A.G. in order to embody the earlier installations in the larger scheme of pressure pipe lines which had then been worked out.

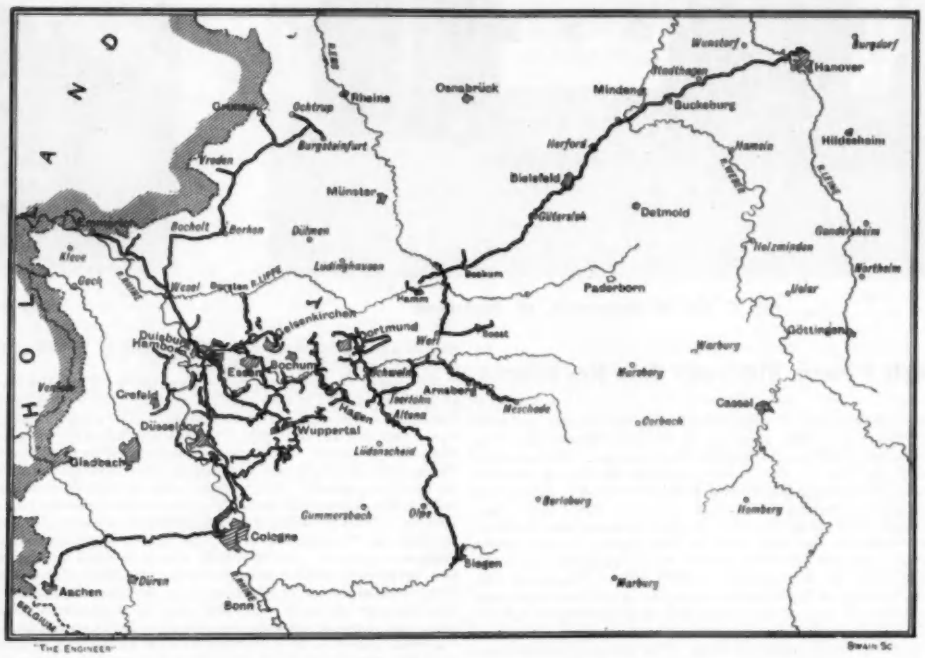


FIG. 1—MAP SHOWING COKE-OVEN GAS DISTRIBUTION PIPE-LINES IN GERMANY

The accompanying map—Fig. 1—gives an indication of the natural development of the principal pipe lines in Germany and shows the density of population of the areas concerned. In the main the pipe lines were chosen to give the most useful and economical scheme of distribution. One of the chief lines runs from the Ruhr district upwards through the thickly populated districts of the Rhineland, while another is that of the Ruhr colliery district already referred to. Another important line starts from Dortmund and runs in a southerly direction through the well-developed industrial district of Southern Westphalia, while another main pipe line runs in an easterly direction to Hanover. It is quite possible that at a later date this particular line may be connected to some of the industrial districts of Central Germany. Since the work was begun the following three important pipe lines have been laid down :—First, the line from the Ruhr district westward to Cologne; secondly, that from Dortmund southward to Siegen in Westphalia; and thirdly, the 180-kilom. or 112-mile stretch to Hanover.

The economy of the first two lines above mentioned was ensured from the first by the fact that they were not solely looked upon as feeder mains supplying gas for distribution by municipal authorities or to public gas distributing companies for the needs of the population and of industry, but that they also supply gas to a large number of iron and steel works closely associated with the colliery interests of the Ruhr district. Whereas in the early days these works received supplies of coal from the associated mines in the Ruhr, they now take supplies of gas, which are delivered from the coke oven plants of the same companies through the pipe lines of the Ruhrgas A.G. In such cases, the companies as shareholders in the Ruhrgas A.G. produce their own gas and only pay to the distributing company a tariff based on the amount of gas and the distance through which it is delivered.

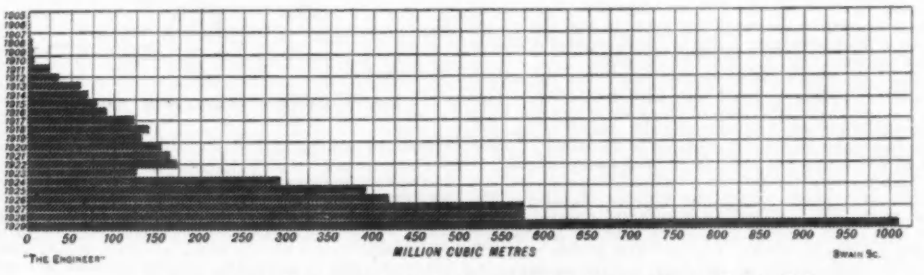


FIG. 2—DIAGRAM SHOWING GROWTH OF DISTRIBUTION OF COKE-OVEN GAS

The financial success of this system of internal gas distribution is ensured by the fact that the Ruhrgas A.G. naturally, when delivering gas to its customers, particularly those associated with the mining industry, always obtains its supply from the nearest coke oven plant and balances the output of gas among the owners of the plants. By such mutual exchange of gas the interests of the various concerns are safeguarded, and a high working economy is achieved, with satisfactory results to all parties. The financial success of the present network has thus been assured, and the mining industry is now in a position to sell gas to the townships and public gas distribution companies at very low prices. The Ruhrgas A.G. is only concerned with the distribution of gas over long distances, and it does not interfere in any way with the local sale of gas and the tariffs which are charged to consumers by the local distribution companies. When a special case arises in which the local gas supply undertaking cannot deliver gas to a large works at a price which makes the alteration of the works plant for gas firing economically worth while, then the Ruhrgas A.G. arranges, at the wish of the town authority, to connect such a works direct with the main pipe line. In this way a new customer is obtained and the local authority, having no outlay in the connecting up of the works and the delivery of gas, can content itself with a smaller price per cubic metre of gas, and with the increased quantity of gas required still makes a good profit.

The following is a general summary of the present position with regard to the long-distance transmission of coke oven gas, and its recent development in Germany :—In the year 1926 no less than 70,272,825 cubic metres of gas were delivered through the R.W.E. network, which was at a later date taken over by the Ruhrgas A.G. In the following year this figure was increased to 82,928,985 cubic metres. In 1928 the pipe lines were taken over by the Ruhrgas A.G., and the R.W.E. network, together with new pipe lines laid down, dealt with 118 million cubic metres of gas. The following year, 1929, 402 million cubic metres of gas were pumped through the Ruhrgas A.G. network. Although the pipe line from Dortmund to Siegen was only completed in the second

half of February, 1930, and the pipe lines to Hanover and Cologne were not yet in service, the output of gas rose from 47 million cubic metres in December, 1929, to 54,800,000 cubic metres in January, 1930. There is no doubt that the opening of the Cologne and Hanover pipe lines this year will bring largely increased throughputs, which will add considerably to the 1930 figure. The steady increase in the quantity of gas handled by the networks is clearly shown in the accompanying diagram, Fig. 2.

The long-distance coke oven gas transmission scheme described, which has been carried out in Germany, has aroused considerable interest in neighbouring countries, particularly in Holland, and similar schemes are now under consideration in those countries. The forthcoming second World Power Conference to be held in Berlin in June will provide an interesting opportunity to acquaint engineers with the position of a type of energy supply new to Europe.

International Congress for Concrete and Reinforced Concrete.

As already announced, the First International Congress for Concrete and Reinforced Concrete, will be held at Liége from September 1st to 6th next. The Council of the Institution of Structural Engineers in the autumn of last year accepted the formal invitation addressed by the Belgian Government to the Foreign Office, and transmitted to the Institution by the Ministry of Transport, to undertake the formation of a British Section to represent this country at the Congress. The British Organising Committee, formed in accordance with this invitation, is as follows :—Chairman, J. Mitchell Moncrieff, M. Inst. C.E. Members : Mr. E. A. Black, A.M. Inst. C.E.; Mr. E. W. Butler, M.I. Struct. E.; Mr. S. D. Carothers, M. Inst. C.E.; Mr. C. S. Chettoe, A.M. Inst. C.E.; Major A. F. Day, R.E.; Lieut.-Colonel E. B. Martin, D.S.O., M. Inst. C.E.; Mr. E. W. Monkhouse, M. Inst. C.E., M.I. Struct. E.; Mr. W. Muirhead, M. Inst. C.E., M.I. Struct. E.; Mr. F. H. Rogers, M.I. Chem. E.; Mr. R. H. H. Stanger, F.C.S., A.M. Inst. C.E., M.I. Struct. E.; Mr. H. D. Searles-Wood, F.R.I.B.A., M.I. Struct. E.; Mr. R. E. Stradling, D.Sc., M. Inst. C.E.

The Committee comprises representatives of the following Departments and allied societies and institutions :—The Ministry of Transport, the Department of Scientific and Industrial Research, the Department of the Civil Engineer in Chief of the Admiralty, the Institution of Royal Engineers, the Royal Institute of British Architects, the Institution of Municipal and County Engineers, and the Institution of Chemical Engineers, who have co-operated in securing the various technical reports and papers which are to be presented at the sessions of the Congress in September.

The Congress will be divided into two Sections, which will be devoted to the consideration of the following groups of subjects, and to the reading and discussion of papers relating thereto. The papers submitted by the British Organising Committee and accepted by the Congress are :—

SECTION I.: THE CALCULATION, REGULATION AND DESIGN OF CONCRETE AND REINFORCED CONCRETE STRUCTURES.

Wednesday, September 3rd.—(*a*) "Stresses in Dams," by Mr. S. D. Carothers ; (*b*) "A Study of Plain and Reinforced Concrete Retaining Walls," by Mr. Ewart S. Andrews, M. Inst. C.E.; (*c*) "Reinforced Concrete in Great Britain," by Mr. A. Kirkwood Dodds, M.C., M. Soc. C.E. (France) ; (*d*) "Reinforced Concrete in Engineering : Representative Examples of British Practice," by Mr. M. Gerard, M. Soc. C.E. (France).

Thursday, September 4th.—(*e*) "Work of the Building Research Station on Small Movements in Concrete," by Dr. W. H. Glanville, A.M. Inst. C.E.; (*f*) "The Effect of Temperature on Flat Arches Constructed of Reinforced Concrete," by Mr. C. S. Gray, A.M. Inst. C.E.; (*g*) "Temperature and Cement," by Dr. Oscar Faber, M. Inst. C.E.

SECTION II.: DEALS WITH THE ACTUAL BUILDING AND ALL THE QUESTIONS RELATING TO IT, SUCH AS PREPARATION OF THE RAW MATERIALS, MACHINERY, OVERLOOKING OF THE YARDS, UPKEEP, &c.

Monday, September 1st.—(*h*) "The Architecture of Concrete," by Professor Beresford Pite, Hon. M.A. (Cantab.), F.R.I.B.A.

Tuesday, September 2nd.—(*i*) "The Composition, Mixing, Methods of Application of Concrete and Reinforced Concrete as used in the Yards and the Control of Same," by Mr. T. R. Grigson, M. Inst. C.E.; (*j*) "Some Notes on the Composition, Mixing and Application of Concrete in Engineering Works," by Mr. C. J. Jackaman, A.M. Inst. C.E.

Wednesday, September 3rd.—(*k*) "Pieces in Concrete Piles," by Mr. M. J. C. McCarthy, A.M. Inst. C.E., A.M. Mech. E.

A NEW FRENCH SUBMARINE.—There was recently launched from the Le Havre yard of Chantiers et Ateliers Augustin Normand the submarine "Diane," a 650-ton vessel constructed for the French Navy. The new submarine is the first of five similar ships under construction at Messrs. Normand's yards, and all of them will be engined with oil motors of the Vickers-Normand type.

ENGINE-ROOM TELEGRAPH CONTROLS.—We recently inspected at the offices of Arens Controls, Ltd., of Dorland House, 14, Regent-street, S.W. 1, the Arens system of positive remote control, enabling either push or pull motion to be transmitted around angles or bends as applied to engine-room telegraphs. The construction, which has been widely and successfully employed for aircraft and motor boat controls, comprises an outer metal casing in which is contained a central flexible cable surrounded by a tightly coiled spring. The push movement is transmitted by the spring in compression and the pull movement by the cable in tension. The installation we inspected incorporated a large number of small radius bends and worked very smoothly. The Arens control units are made in various sizes ranging from $\frac{1}{4}$in. up to $\frac{1}{2}$in. inside diameter upwards for the sliding member and can be designed to transmit any desired load. The outer casings can be supplied in plain or chromium plated brass, aluminium, duralumin or steel, and certain of the smaller sizes of controls in casings of flexible metallic tubing.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Persistent Depression.

DEPRESSED conditions persist in Midland and Staffordshire engineering and manufacturing industries, and trade in iron and steel is, as a consequence, very flat. Very little movement is discernable in any department, nor are there evidences of probable improvement in the near future. Under these circumstances, there is a general reluctance to enter into contracts or to buy raw material at all outside the limits of immediate requirements. The outlook is discouraging and many district industrialists this week stress the gravity of the situation.

Pig Iron.

At the time of writing, the result of the deliberations of the associated blast-furnacemen in the Midlands was not to hand, and it was an open question whether a new range of prices would be announced or whether furnacemen would again adhere to recent price levels. The persistent abstention from buying which has prevailed for months past must have been more or less keenly felt by producers, and there was quite a large body of opinion that smelters would see the necessity for price concessions. Very little buying has been done during the week, and what business has been put through has been at the fixed minimum arranged by the Central Pig Iron Producers' Association. So far, furnacemen have acted with a unanimity which has surprised consumers. Especially is this so when it is recognised that quite an amount of iron has of late been going into stock. In Derbyshire the allied business of cast iron pipe making has kept up well, in spite of the general depression, so that a fair amount of Derbyshire iron is needed on that account. Northampton makers are not so fortunate, and more of this iron is undisposed of. Makers would be glad to see orders coming along and some of them will probably advise a reduction in selling prices in order to stimulate business and encourage the placing of larger orders. Midland foundries, whether engaged for the engineering or light castings trades, are less active than is usual at this time of the year, while the forges are doing extremely little. It is held that a reduction in raw iron prices would assist forge and foundrymen to better times, but whether smelters agree or not, they are unlikely to reduce their charges unless they consider it in their own interests and those of the raw iron industry in this area in general. At date there is a plentiful supply of furnace coke. Ovenmen are endeavouring to maintain a minimum for new contracts, but odd lots can be secured on favourable terms.

Staffordshire Bar Iron.

There is a steady demand for best grade Staffordshire bar iron at £12 10s. per ton, and works are regularly employed, though in some cases not up to full capacity. The position in this department is so far established that both producers and consumers are able to look ahead with some degree of certainty, and plans for a limited future are being made. Finished iron makers generally, however, complain that there is little easing of the competition of steel. Buyers continue to look at the first cost of finished iron without realising that in the long run it is a better investment, owing to its superior quality and strong resistance to corrosion. Makers are constantly endeavouring to persuade users that genuine Staffordshire puddled iron is eminently suitable for outdoor work. In some cases there is an increasing tendency to use iron instead of steel, but in others the cheaper material has got such a hold that ironmasters almost despair of wresting the business from their competitors. There is no improvement in the Crown and common bar branches of the finished iron trade. If anything, it must be admitted, matters are slightly worse. The consuming industries are poorly engaged and have little need of fresh supplies. Crown bar makers continue to quote up to £10 7s. 6d. per ton for their product, but it is claimed that few of them, if any, would refuse an order if offered at several shillings per ton below this figure. Makers from districts outside Staffordshire are prepared to do business at below £10 per ton. Nut and bolt and fencing bar manufacturers have little work on hand and less in prospect. If, as is the case, continental material used for similar purposes fails to find purchasers, there is small hope for local manufacturers who require an additional £3 per ton for their material over the figure asked by their foreign rivals. Sales of wrought iron strip are picking up again, and values are firm at £11 2s. 6d. per ton.

Steel.

In the heavy steel trade the steel mills are short of orders, and are anxiously seeking specifications. Only in rare cases is there any marked activity in the general engineering trades, while Midland constructional engineers find business decidedly slow. New contracts are small and scarce, and are only to be secured at "cut" prices. Special steels for the motor engineering industry remain in fair request, and there is a moderately good call for some classes of plates. On the whole, however, there is little demand for finished steel. Makers say that under the rebate scheme they still have the support of the majority of big users of steel, and they do not attribute the present condition of the industry to foreign competition, but to a general lack of consumptive demand. Prices fixed by the Association are constant. Angles are quoted £8 7s. 7d.; tees, £9 7s. 6d.; joists, £8 10s.; ship, bridge and tank plates, £8 17s. 6d.—all subject to rebate. Boiler plates command £9 12s. 6d. upwards, and Staffordshire hoops £10. Small rolled bars range from £8 to £8 15s., and mild steel billets from £6 upwards. In semi-finished steel business is confined to narrow limits, and Birmingham merchants report as much difficulty in disposing of foreign as of native material. Steel strip sells fairly well, and makers have tolerably good order books.

Galvanised Sheets.

Business continues poor in the galvanised sheet industry, demand from overseas being particularly flat. Inquiries amongst manufacturers fail to reveal even one bright spot in the export market. Sheet makers, after carefully considering the present trading conditions, have come to the conclusion that it is best for the time being not to make any alteration in selling rates, except in the case of 30 gauge sheets. A reduction in this branch of 10s. per ton, bringing the selling price to £15 7s. 6d., has, however, been made. Galvanised corrugated sheets of 24-gauge are fixed at a minimum of £11 17s. 6d., it being considered improbable that any material increase in demand would follow a lowering of values. Black sheets are in moderate request at recent selling rates, but trade is not up to normal, even in this branch.

Scrap.

Heavy steel scrap continues almost unsaleable, and values have further declined. It is reported this week that offers of supplies at £2 7s. 6d.—6d. per ton below last week's lowest figure—have been made to South Staffordshire works, while North Staffordshire consumers have been offered material at £2 10s. delivered. Even tempting prices like these, however, fail to secure acceptance. Prices for turnings are unprocurable, Birmingham merchants refraining from stating prices. The scrap market generally is lifeless.

Orders Secured by Midland Firms.

Some useful orders have just been secured by Midland rolling stock and engineering firms. The Birmingham Railway Carriage and Wagon Company, Ltd., of Smethwick, is to make four atmospheric tank wagons for the Buenos Aires and Pacific Railway, while the Gloucester Railway Carriage and Wagon Company, Ltd., is to supply the San Paulo (Brazilian) Railway with eight second-class bogie carriages. The Sentinel Waggon Works, Ltd., of Shrewsbury, has received an order from the London and North-Eastern Railway for eighteen 100 H.P. double-geared and one 100 H.P. single-geared "Sentinel" shunting locomotives. The Horsehay Company, Ltd., Shropshire, has received from the Great Western Railway an order for miscellaneous steel girder work for constructional purposes to the value of some £7000.

Proposed Expenditure of £10,000 on Mains and Switchgear.

The Electricity Committee of the Coventry Corporation recommends the City Council to carry out work on new mains and switchgear in connection with the supply of current to houses in course of construction at Goodyear's End, Exhall, and a further supply to the Stoke (Coventry) works of the General Electric Company, Ltd., at an estimated cost of £10,168. It suggests that application should be made for sanction to a loan for that amount to the Electricity Commissioners.

£32,888 Sewage Scheme.

The Ministry of Health has approved the Perkridge sewage scheme, which is estimated to cost £32,888, and it only remains now for the Council's engineer to discuss with the Ministry certain details of the scheme before the work can be commenced.

Old Hill Mines Abandoned.

Intimation has been received from the Secretary of Mines that the Old Hill mines drainage scheme of 1922 has been annulled. This means in effect that the mines in the Old Hill area have been definitely abandoned. None of these mines have been able to work for several years, but evidently no further steps are to be taken to deal with the water problem. Owners of collieries in the nearby area of the Lye are concerned lest the water should now find its way into their area.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Large-scale Rationalisation.

AN important rationalisation scheme affecting Lancashire iron, steel and coal interests, which has been under discussion and negotiation for some time, has now reached an advanced stage and the Railway and Canal Commissioners are to be approached to secure confirmation of the conditional agreement that has been reached. Naturally, the financial details of a project which will have an aggregate capital of nearly £8,000,000 and embrace six of the largest undertakings in the county are exceedingly complex and no more than a brief outline can be given here. The businesses affected are the Partington Steel and Iron Company, the Pearson and Knowles Coal and Iron Company, the Wigan Coal and Iron Company, the Moss Hall Coal Company, Rylands Brothers and the Wigan Junction Colliery Company. As the titles of several of the companies imply, iron, steel and coal all come within the scope of the individual activities, and the outstanding feature of the scheme is to merge the whole of the coal business into a new body to be known as the Wigan Coal Corporation, with a total capital of £2,246,555—including £500,000 debenture stock—and to deal similarly with the iron and steel branches by the formation of the Lancashire Steel Corporation, with a nominal capital of £5,750,000.

Cutting Out the Waste.

Altogether, sixteen collieries—fifteen in Lancashire and one in Nottinghamshire—will come under corporate control. A number of the collieries are in close proximity one to another, and as the several companies have their own selling and distributing organisations, appreciable economies in this direction are anticipated.

Further substantial savings are expected to result from the common ownership of wagons and from the central purchasing of stores. The coal seams which will come under the control of the Corporation are estimated to be capable of yielding about 350,000,000 tons, with an aggregate annual output of over 3,300,000 tons. The Bank of England's offshoot, the Securities Management Trust, will have voting control of the Lancashire Steel Corporation, which, in turn, will have control of the Wigan Coal Corporation. From the point of view of the iron and steel industries an important feature of the scheme is that plant developments in the Manchester district are contemplated which, it is claimed, will result in the most up-to-date and efficient iron and steel works in the country being established at Irlam, a few miles outside the city.

Crewe's 6000th.

Within the past few days an interesting milestone in the history of the Crewe locomotive shops of the London, Midland and Scottish Railway was marked by the completion of the 6000th engine to be turned out since the works were originally established in 1843 by the Grand Junction Railway. The locomotive in question was one of a hundred 2–6–0 mixed traffic engines under construction at Crewe. Eighty-seven years ago the shops covered an area of between 2 and 3 acres, but to-day they extend to over 50 acres.

More Capital for Electrical Engineers.

Subject to slight amendment, the Vice-chancellor, Sir Courthope Wilson, approved a scheme of arrangement for the reorganisation of the capital of Ferranti, Ltd., electrical engineers, of Hollinwood, near Manchester, which provides for an increase in the capital of the company to £900,000 by the creation of 300,000 new preference shares of £1 each and 600,000 ordinary shares of 10s. each. The purpose of the new capital is to meet present financial requirements and to provide for the extension and development of the business.

Developments in Brief.

A scheme for the prevention of erosion by the river Mersey in the vicinity of Manchester has been approved by the various Lancashire and Cheshire authorities concerned and an early start will probably be made. The cost is estimated at about £150,000. The Building and Bridges Committee of the Salford Corporation has passed the plans for a new five-storey grain elevator to be erected alongside the Manchester Ship Canal at Ordsall-lane by Messrs. W. and F. Paul, grain importers, of Ipswich. Manchester Transport Committee has decided this week to purchase thirty double-deck motor buses at a cost of £50,550 to replace tramcars on the Bradford-road route. It has also decided to buy fifteen additional buses for service on the recently converted circular route, known locally as "53."

Non-ferrous Metals.

Though not pronouncedly so, the swing of the non-ferrous metals price pendulum this week, except in respect of copper, has been in an upward direction. The price outlook, however, is still regarded with a marked lack of confidence. In the case of tin in particular, the statistical position at the moment continues to be all against any real strengthening of values and trade buying of the metal is on cautious lines. Stocks at port warehouses in London and Liverpool are substantial and in view of the further increase in them during the past week a recovery in prices to the extent of about 30s. a ton is, perhaps, as much as one could expect. For all practical purposes copper at the moment of writing is at about the same level of values as it was a week ago, but there has been a remarkable decline in buying interest in all sections. A rise of about 5s. a ton in lead and one of 10s. in spelter may be said to complete the story of market developments during the week. In both metals, however, reports all round refer to inactive conditions and in the aggregate the turnover has been relatively small.

Iron and Steel.

Prices have been held in the pig iron section of the markets here, but there has been no improvement in business booked, though a slight expansion in the call for material against contracts already on the books of the blast-furnaces has been reported by one or two sellers in Lancashire. Staffordshire and Derbyshire No. 3 foundry iron is at 77s. per ton, delivered Manchester, or equal distance; Scottish at about 95s.; West Coast hematite at 91s. Bar iron is quiet at the lower range of £10 5s. per ton for Lancashire Crown quality material and £8 15s. for seconds. A slightly better inquiry for steel has been experienced in some quarters, but it has been by no means general, and so far as actual new bookings and contract deliveries are concerned, Lancashire business this week has been very slow in most directions, one or two speciality branches of engineering being, perhaps, the exceptions. Re-rolled bars have further weakened, but in all other respects quotations keep up at late rates. Conditions among Lancashire re-rollers are particularly slow and a reduction of 2s. 6d. a ton has again been put into operation, the revised prices being £7 17s. 6d. to £8, according to quantity. Where the possibility of business exists, sellers of imported iron and steel products here are not hesitating to cut Cartel figures and some low prices have been indicated on this market during the past week.

BARROW-IN-FURNESS.

Hematite.

There is still a weakness in the market, which, despite reduced prices, has not improved. Makers hold orders which will keep them going for a period of seven or eight weeks at the present rate of output, but unless fresh orders come in there will have to be restriction of output. Orders which are being booked now are for small tonnages, simply to meet immediate requirements; but there is a falling off in orders for forward delivery. The continental business is maintained and further American orders are likely in the early future. More iron has come into the market owing to the temporary stoppage of the steel works in Cumberland. Stocks will increase in several works. The iron ore trade, so far as the local demand is concerned, is about the same, but the business outside the district is not heavy. The steel trade cannot be said to be bright and such orders as are held can be dealt with in a short period. Fresh orders would be very welcome. The demand for hoops is fair.

SHEFFIELD.

(From our own Correspondent.)

Steel Conditions Quiet.

THE signs of improvement in the steel trade, which some authorities appeared to discern last week, have not become any more pronounced yet, and the situation, if changed at all, is changed for the worse. Especially is this the case in regard to crude steel products, such as billets, rods, and sheets. For all these, the demand is so restricted that production at the open-hearth furnaces shows a further shrinkage, alike in North Lincolnshire and in the Sheffield area. A very significant indication of the extent to which Sheffield's armament work—which was formerly on such a huge scale—has fallen off since the war, is contained in the annual report of John Brown and Co., Ltd., which states that the orders for armour-plate during the past year amounted to less than 50 tons. Messrs. Brown are one of the firms which have specialised in the production of large hollow forgings for boilers and other drums, and, as I have several times mentioned, they have for some time been very busy in that department. The directors, however, mention that it has only been possible to obtain this work in the face of severe home and foreign competition. The position with regard to railway steel does not improve, and the great plants which have been laid down for the quick manufacture of tires, axles and springs, are only partially employed. Work from overseas is very scarce in this department, and the stream of orders from the home railway companies, although rather better than that of last year, is not up to the normal.

The Manufacturing Side.

There is a good flow of orders from the home market for manufactured steels of the better qualities, but they are for the most part small, and competition for the work is very keen. Prices are, consequently, being so severely cut that in many instances business is unremunerative, and in some cases orders are being executed at a loss. The trade in automobile supplies has not yet returned to a normal level. During the period of apprehension preceding the Budget, motor car manufacturers kept their orders down very much. When it became known that the McKenna Duties were safe for the present, there were hopes that trade would improve, but so far makers are only ordering to cover their immediate requirements. Even the fact that prices of much of the material that they use have become cheaper since the beginning of the year, and that this is a favourable time for buying, does not tempt them. The demand for stainless, non-corrodible and heat-resisting steels, although still large, is not up to a really satisfactory level. A few firms are doing a valuable amount of work in cold-rolled steel and strip. The branch dealing with high-speed steel tools, cutters and twist drills is better situated than many others, as a moderately good demand from the home market is being experienced. For agricultural implement parts the demand is steady, though limited. The season for farm and garden tools has not been satisfactory so far.

Hacksaws and Shovels.

One bright spot in the situation is the well-sustained trade in hacksaws. This industry is only 25 years old in this country, but it has made wonderful progress. Sheffield hacksaws enjoy a high reputation abroad and have particularly good markets in Belgium, Scandinavia and one or two other countries on the Continent. Not long ago it was reported that one of the leading Sheffield makers had carried out extensions which would double their output, and now it is announced that large extensions are being made by another firm—James Neill and Co. (Sheffield), Ltd.—who are building a new, up-to-date factory on a site, the clearance of which has necessitated the demolition of twenty-one dwellings. It is also pleasing to know that the trade in British shovels and spades is in a very healthy condition. In this line, British products hold a supreme position not only at home, but abroad. Our exports of such implements last year ran to three and a half millions, of a total value of £357,846, whereas our imports numbered only 5000, valued at £394. Although Sheffield is not the only place in this country where shovels and spades are made, it still enjoys a large share of the trade.

A Busy Year.

If all years could be as good as last year, the Parkgate Iron and Steel Company, Ltd., would soon find itself in a more prosperous position than it has held for for some time. The annual report shows that, during the twelve months ended March 31st, the whole of the works were in continuous operation, and the output of steel ingots reached 179,900 tons, which was a record. Seeing that in the previous period there was an increase of 6785 tons, it is evident that progress is being made. The profit, after providing £20,000 for depreciation, was £42,007, which was sufficient to extinguish the debit balance and leave £4235 to carry forward on the credit side. The report states, however, that during the last three months of the year there was a considerable falling off in trade in iron and steel, as in all other industries. This increased the difficulty of keeping the plant in full operation, and there are no indications of an early improvement. It is also mentioned that plant development has made good progress and should become immediately remunerative.

John Brown and Co.'s Reconstruction.

It is not pleasant to turn from this report to that of the great firm of John Brown and Co., Ltd., to which I have already referred. Here, the directors are only able to report a profit of £24,184, and they do not propose any dividend on either the ordinary or preference shares. The last ordinary dividend was in 1925, and the preference dividend is a year in arrear. In their reference to the shipbuilding work of the company, the directors mention that an important tender has recently been submitted for a large express Atlantic liner. The most serious part of the report refers to a drastic scheme of capital reconstruction which the directors propose. Under this, the share capital is to be reduced from £4,500,000 to £2,375,000. The ordinary shares are to be written down from £1 to 6s., and the 5s. which is due on the 1,250,000 15s. paid shares is to be called up. The £10 preference shares are to be split up into £1 shares, and then reduced to 12s. The present arrears of preference dividend are to be cancelled, and the preference shares in future are to be non-cumulative, though, in compensation for this, the rate of dividend is to be raised from 5 to 7 per cent. The debenture holders are asked to consent to the postponement of the date of maturity of their debentures until December 31st, 1965, at enhanced interest.

More Rationalisation Coming.

It is clear that Brown's are about to follow the example of the other two great Sheffield armament and shipbuilding firms—Vickers and Cammells—and rationalise. They are already closely associated with the firm of Thos. Firth and Sons, Ltd., and for some time it has been rumoured that they were about to enter into a complete amalgamation with them. Lord Aberconway, the chairman of John Brown and Co., is reported to have said, in an interview, last week, that the matter would be carried through. It has not yet, however, reached a definite stage. In his letter to the shareholders, explaining the reconstruction scheme, Lord Aberconway states that "proposals have been made to the board for joining in amalgamations with other companies for the purpose of rationalisation of certain important sections of the company's business, but up to the present no proposal has been made to the directors which, without improvement, would justify them in recommending it for acceptance by the debenture holders and shareholders. "Combination in some form," he emphasises, "must be achieved with a view of avoiding reckless competition and eliminating the cost of maintenance and upkeep of the surplus plants which are still operating in the country. This position is being actively dealt with in the shipbuilding industry and is being closely investigated by the directors in other directions."

Atlas and Scunthorpe Works.

"The board are advised," continues Lord Aberconway, "that the scheme now proposed should first be carried out and that, immediately thereafter, the position in regard to the Atlas (Sheffield) and Scunthorpe works should be dealt with in a rationalisation scheme in order to effect economies in the heavy forgings and castings trades which is manifestly required by all those engaged in them. Power to deal with these works by sale or amalgamation is, therefore, asked from the debenture holders."

Orders for Sheffield Firms.

A list of new Government contracts just published shows that several Sheffield and district firms are to supply goods to different Departments. The Admiralty is taking crank shafts from Thos. Firth and Sons, Ltd.; the War Office has ordered bullet-proof plates from Hadfields, Ltd.; round steel from the English Steel Corporation Ltd., and steel bars from W. Jessop and Sons, Ltd. The Crown Agents for the Colonies have given orders for pipes to the Staveley Coal and Iron Company, Ltd.; for steel to S. Osborn and Co., Ltd., and for steel tires to the English Steel Corporation, Ltd. Steel work is being supplied to H.M. Office of Works by W. H. Blake and Co., Ltd. Another local order is one placed by the Rhodesia Railways with Cravens Railway Carriage and Wagon Company, Ltd., for one family coach body. Still another is one received by General Refractories, Ltd., for high-alumina firebrick, for use in connection with oil-fired furnaces in New Zealand.

Cutlery and Plate.

The cutlery and plate trades remain in much the same state as previously reported. While there is a large output of stainless table cutlery, it is not on the level of a few years ago, and the demand is, to a growing extent, for the cheaper qualities. Trade through the ordinary shopkeeping channels is slow, but there are a few valuable contracts on hand for the equipment of hotels and steamships with cutlery and plate of high quality. A steady demand exists for best pen and pocket cutlery. The Admiralty has just placed orders with a number of firms for cutlery and plate. The scissors branch is active, and the trade in safety razor blades reaches large proportions, though the demand is not quite equal to a year ago. It is reported that an American firm has patented a new type of safety razor frame and blade, so designed that no other make of blade will fit it and that it is intended to carry on in this country a great scheme of free frame distribution in order to popularise the new article. As the success of such a scheme would adversely affect the trade in Sheffield blades, the local makers, numbering about a dozen, are considering the desirability of concerted action in order to combat its effects. In some quarters, it is considered that the American blade is not patentable and there are threats of opposition to the patent in Germany. The blade is partly made in Sheffield of Sheffield strip, and is finished in the United States. The old-established cutlery firm of George Wostenholm and Son, Ltd., is proposing to carry out a capital reconstruction scheme on terms which are favourable to the shareholders.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Decline.

FEARS are entertained in many quarters in the North of England that there is developing a steady decline in the activity of industry in general. The outlook for the iron and steel trade is very discouraging. During the early part of the year business was fairly brisk, and manufacturers were able to maintain good outputs. In recent weeks, however, the position has taken a turn for the worse, and at present the indications are that a period of sluggish trade lies ahead. Production is being severely curtailed. Moreover, continental producers are again resorting to undercutting, and manufactures of this district are becoming almost unsaleable abroad. Everyone connected with the coal trade is also becoming deeply concerned with the situation. Unemployment figures in the mining areas are growing daily, and an increasing amount of short time is being worked at the pits. As near as can be ascertained there are about 35,000 men idle in the Northumberland and Durham coalfields. In many instances the men are being stood off temporarily because of lack of orders, but somewhere between 20,000 and 22,000 men may be regarded as wholly unemployed. It is predicted that next month will see the situation worse than it has been since the beginning of last year. The two principal reasons given for the falling off in the trade are the uncertainty caused by the Coal Mines Bill and the fact that continental buyers are still well stocked from last year's purchases, made in preparation for a hard winter which failed to arrive.

Cleveland Iron Trade.

While the volume of business in the Cleveland pig iron trade is far below normal, some little expansion of inquiry is very welcome. Buyers have held off the market so long that they are very bare of stocks, and, to a limited, extent, are beginning to make purchases. There is, moreover, a rather better inquiry on export account, and this has created a slightly more hopeful tone. Output, however, is rather more than sufficient to meet current needs, with the result that the already considerable stocks are being added to. Producers urgently need a brisker flow of orders. Prices are steady, No. 1 Cleveland foundry iron being 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; and No. 4 forge, 66s.

Hematite Pig Iron.

Home and continental users of hematite pig iron are paying more attention to the North-East Coast market. Business has been put through with Sheffield consumers, and small odd sales to overseas firms are reported. Stocks are heavy and still increasing, but additions are not now large. Makers of East Coast brands quote on the basis of 74s. for ordinary qualities, but are stated to be accepting less. Merchants continue to undersell producers, though they no longer possess substantial quantities.

Iron-making Materials.

Consumers of foreign ore are not in the market. Merchants are prepared to give favourable consideration to offers at much lower figures than have ruled recently. Blast-furnace coke is plentiful and weak. Good average qualities are now obtainable at 17s., delivered to North-East Coast works.

Manufactured Iron and Steel.

Business in the manufactured iron and steel trade has shown just a slight improvement during the week, but there is a very great deal still to be desired. A few small contracts for railway material are being booked, but there has been a falling off in the demand for shipbuilding requisites. The Cargo Fleet Iron Company, Ltd., Middlesbrough, has secured an order for 10,000 tons of steel rails. This is part of the contract which the High Commissioner in London for the Union of South Africa has placed with British steel makers for 47,000 tons of rails and fish-plates. Prices are unchanged.

The Coal Trade.

The entire coal trade of the Northern counties is very dull, and every producer could handle very substantially increased business. There are more signs of lack of trade in Durham County, with its corollary of less regular employment for the miners. Here and there seams are being temporarily closed, and even in large groups of pits it is not easy to get in more than four days per week. Except in relatively few instances, orders are constantly needed to keep collieries going. Even collieries that are favoured by having staiths within a short distance of the pithead are unable to secure sufficient business to avert lost time. Northumberland is better off for prompt orders than Durham, and fitters are looking forward to steady working over the next week or two. There is a certain amount of firmness in the best classes of steams, and 13s. 6d. is a minimum price, but other grades are not doing so well. Steam smalls are less active than large, but prices are not changed. Curtailed output of Durham gas coals has not had any effect on the general position, as supplies are ample. Best qualities are offered at 15s. 9d., and secondary kinds at 13s. 6d. Coking unscreened are quite a steady section of the market, and are quoted firm at 13s. 6d. to 13s. 10½d. Bunker coal is in active request for best grades at an average value of 14s. 9d., but second qualities are pressed on the market at 13s. 6d. Coke makers and exporters consider that the proposed coke cartel scheme is dead for the present. Whether it will ever be revived, time will show. It bristled with difficulties, and it was impossible to arrive at agreement. Scandinavian consumers are not eager to buy at present, it is said, being content to let matters settle down before they seek fresh supplies. The export foundry section remains dull, with ordinary qualities offered freely at 18s. The higher classes are at 20s. to 24s. Beehive coke is in small output, and prices are unaltered at 26s. to 29s. June purchases of gas coke are expanding, and sellers adhere to a firm 21s. 6d.

SCOTLAND.

(From our own Correspondent.)

Continued Dullness.

So far as can be ascertained nothing has occurred during the past week calculated in any way to lessen the depression existing in the steel, iron and coal trades. Producers continue to carry on in the hope of better things, only reducing outputs when absolutely forced to do so. Mills are running below capacity and employment at the collieries is considerably below normal. Competition is apparently just as severe outside the basic industries and lately some large manufacturing concerns have made drastic reductions in staffs and working hours, and here and there rumours have been in circulation concerning the probable closing down of some establishments for a time at least. On the other hand, if orders expected to be placed in the Clyde area materialise, the situation may be considerably relieved, though, of course, the actual effect may not be apparent for some little time. At present the outlook for the next two or three months at least can hardly be termed otherwise than discouraging.

Steel.

The present output of steel plates and sections is on a reduced scale, which is only maintained by the exercise of considerable effort, owing to restricted demands from the shipbuilders and other consumers. Export orders, too, are on a poor scale. Prices, where fixed, are, of course, unchanged, but otherwise there is a weaker tone.

Sheets.

There has been a decline in the demand for light black sheets, which have been the principal source of business for some time past. Heavy sheets are poorly supported and galvanised descriptions are dull. The last named are quoted about £12 15s. home and £12 5s. per ton for 24-gauge.

Iron.

Bar iron and re-rolled steel makers have nothing particularly interesting to report. The anticipated seasonal expansion in trade has not occurred so far and business all round is extremely dull. Bar iron is unchanged at £10 5s. per ton for home—fixed—and £9 15s. for export, with re-rolled steel at £7 12s. 6d. per ton for home or export; but in all likelihood the unfixed quotations could be shaded for a good prompt order.

Pig Iron.

The demand for pig iron is not only unsatisfactory, but the production is considered unprofitable, and, in all probability, the number of furnaces in blast in Scotland, at present amounting to twenty-seven, will be reduced in the near future. Consignments of pig iron continue to arrive from India and the Continent. Fixed minimum prices are unchanged.

Scrap.

The demand for scrap has fallen off considerably and the market is now much weaker, with heavy steel about 55s. to 57s. 6d.; heavy basic, 59s. to 60s., and cast iron machinery, 67s. 6d. per ton.

Coal.

The coal market is weak all round. Home demands, especially for household purposes, have been declining for months, while the quantities necessary for ordinary utility purposes are practically at their lowest. Consequently, as export business meanwhile is more or less stagnant, activity on the whole is on very restricted lines. All descriptions of round fuel are weak, and the apparent firmness in some sizes of washed materials is accounted for by reduced outputs.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

IT is questionable whether anyone associated with the steam coal trade would be prepared to deny that the industry is now passing through one of its worst periods of depression. It is doubtful also whether anyone could be persuaded to say that there is any indication of an immediate improvement. Most pits have worked more irregularly during the past week or so than at any time this year. This fact is not surprising when the returns at the end of last week showed that, taking the leading ports in South Wales, the number of idle tipping appliances reached the extraordinary number of fifty-seven. Arrivals of tonnage over the week-end did not improve the situation as much as could have been desired, as on Monday the position was that there were still thirty-two tips idle and only one steamer waiting to berth and that at Swansea. Shipments, according to the Great Western Railway Company's figures, were last week just over 510,000 tons, which compares with the weekly average of over 600,000 tons for the first quarter of this year. Half a million tons per week is far from sufficient to keep the collieries in this district actively engaged, and unfortunately there is no prospect of the conditions becoming better in the state of trade at present ruling. The inquiry for coals is not forthcoming from foreign consumers and the foreign coaling stations continue to keep quiet, with so much less tonnage on the move. It cannot be denied also that the inland demand for coals has contracted to some extent, so that in all the circumstances the collieries are having a most anxious time. An inquiry from abroad for even a single cargo is, in the conditions prevailing, magnified out of importance, and the competition for it is extremely keen, business being in some instances taken at a loss and for the sole purpose of enabling the collieries to work with something like regularity, though this is very difficult.

Craftsmen and the Coalowners.

The executive council of the South Wales and Monmouthshire Colliery Enginemen, Boilermen and Craftsmen's Association met last week at Cardiff to consider the future position of its members under the Coal Mines Bill as affecting their conditions of employment and wages. A serious view was taken of the situation and the general secretary was instructed to communicate with the coalowners with a view to discussing the matter. The council considered it necessary that the position of the members should be made clear in the event of the seven-and-a-half-hour day being imposed upon the industry. This meeting was followed on Saturday by the quarterly meeting at Swansea of delegates of the craftsmen and mechanical workers in the Welsh anthracite district. This conference repudiated the idea that the secretary of the South Wales and Monmouthshire Enginemen, Boilermen and Craftsmen's Association could speak for the craftsmen and mechanical workers in the anthracite area, and it was decided to warn the coalowners that they would not accept the terms of any agreement except one made by the representatives of the South Wales Miners' Federation. It was stated that the South Wales and Monmouthshire Enginemen, Boilermen and Craftsmen's Association had not a single member in the anthracite district.

Tin-plate Industry.

The annual meeting of the men's section of the Welsh Tin-plate Joint Industrial Council at Swansea on Saturday decided to put before the annual meeting of the Joint Industrial Council a number of claims, including payment for the holiday week and a superannuation scheme in the industry. It is also announced that after negotiations which have been carried on for a very long time, a sub-committee of the Joint Industrial Council reached on Monday an agreement on the question of the wages of the picklers in the tin-plate mills. The claim of the workmen was that a universal piece rate should be introduced in place of the existing varying datal rate. It is understood that the sub-committee has decided that a rate of 9s. per 100 boxes should now be applied. A few minor details have yet to be settled, and it is understood that there is to be another meeting of the sub-committee to receive reports on inquiries at works where it is claimed that higher rates are being paid.

Current Business.

New business is at a very low ebb and the bulk of the collieries are simply working as well as they can on the strength of contracts entered into some months ago. There is no real market, inasmuch as prices are all at the minimum levels under the stabilisation scheme. Many collieries have of late worked so irregularly that the supply of small coals is very restricted, and these qualities are comparatively steady, but large coals are much in excess of current demand, and standing stocks are extremely heavy. Coke is in fair request, and considering the conditions patent fuel works are not badly off for orders. Pitwood is steady round about 26s. to 26s. 3d., but this is not due to the demand for supplies so much as the fact that the quantity on offer on the market is reduced.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ROYLES, Ltd., of Irlam, near Manchester, asks us to announce that the address of its London office has been changed from Suffolk House, Laurence Pountney-hill, E.C. 4, to Aldwych House, Aldwych, W.C. 2.

THOMPSON BROTHERS, 155, Fenchurch-street, E.C. 3, inform us that as from June 1st their general offices will be transferred from the City to their works at Lewisham. Their new address will be Gilmore Works, Gilmore-road, London, S.E. 13.

MR. T. L. REED-COOPER, M.I. Mech. E., of Abbey House, Westminster, asks us to announce that he has purchased the goodwill, drawings, patterns, &c., of Submersible Motors, Ltd., with a view to combining that business with his own in "Electromersible" pumps.

THE LEA RECORDER COMPANY, Ltd., of 28, Deansgate, Manchester, asks us to announce that it has opened an office and showroom in London at Parliament Mansions, Orchard-street, Victoria-street, S.W. 1. Telephone, Victoria 0984. They are in charge of Mr. J. E. Crawshaw.

MR. H. T. TIZARD, C.B., F.R.S., Rector of the Imperial College of Science and Technology, is to be President of the Association of Special Libraries and Information Bureaux for the year 1930–1931 in succession to Sir Joseph J. Thomson. His year of office dates from the annual conference of the Association, to be held at New College, Oxford, in September.

GEORGE EMMOTT (PAWSONS), Ltd., asks us to announce that the business, established 1840, hitherto carried on by F. E. Pawson and C. A. Pawson under the name of George Emmott at Wadsworth Mills, Oxenhope, near Keighley, has been converted into a private limited liability company under the title of George Emmott (Pawsons), Ltd. The business will be conducted on the same lines as in the past.

ALDERMAN E. B. LEWIS, J.P., President of the National Chamber of Trade, has been appointed by the President of the Board of Trade as an additional member of the Committee recently set up under the chairmanship of Lord Chelmsford to examine the present situation as regards the British Industries Fair, and to consider what means can be adopted to increase still further its utility to British trade.

CATALOGUES.

PARSONS OIL ENGINE COMPANY, Ltd., Town Quay Works, Southampton.—Catalogue 104 on Y series engines.

PETER BROTHERHOOD, Ltd., Peterborough.—Brochure R.D. 330 on the Brotherhood Ricardo high-speed Diesel engine.

DOUGLAS LAWSON AND CO., Ltd., Birstall, near Leeds.—A catalogue giving the range of wrought iron pulleys made by the firm.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—A 200-page book on overhead line equipment materials for power, traction and telephones.

DAVID BRIDGE AND CO., Ltd., Castleton, Manchester.—Particulars of the Bridge-Hulsmeier high-speed stranding machine for the electric cable and wire rope trades.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/–
(1) Spanish	21/6 to 23/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	21/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 10 0	3 10 0
Silicous Iron	3 10 0	3 10 0
No. 3 G.M.B.	3 7 6	3 7 6
No. 4 Foundry	3 6 6	3 6 6
No. 4 Forge	3 6 0	3 6 0
Mottled	3 5 6	3 5 6
White	3 5 6	3 5 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	— *	—
„ „ Foundry	— *	—
(3) Northampton—		
Foundry No. 3	— *	—
Forge	— *	—
(1) Derbyshire—		
No. 3 Foundry	— *	—
Forge	— *	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	4 8 6 (*a*); 4 10 6 (*b*); 4 14 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 17 6 to 8 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 0 0 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/3
Block Tin (cash)	143 5 0
„ (three months)	145 5 0
Copper (cash)	53 17 6
„ (three months)	53 17 6
Spanish Lead (cash)	18 0 0
„ „ (three months)	18 1 3
Spelter (cash)	16 18 9
„ (three months)	17 12 6
MANCHESTER—	
Copper, Best Selected Ingots	61 10 0
„ Electrolytic	61 15 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price), lb.	0 1 0½
Brass Tubes (Basis Price), lb.	0 0 11½
„ Condenser, lb.	0 1 1½
Lead, English	19 12 6
„ Foreign	18 2 6
Spelter	17 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	3/1 per lb.	
Ferro Tungsten	2/10 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£40 0 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 0 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	14/–
„ „ Splint	15/– to 16/–
„ „ Trebles	12/– to 12/6
„ „ Doubles	11/6
„ „ Singles	10/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
„ „ Jewel	16/–
„ „ Trebles	12/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	10/3 to 12/9
Screened Navigation	16/6
Trebles	13/– to 14/–
Doubles	11/6 to 11/9
Singles	10/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/–
Secondary Steam	11/6
Trebles	13/–
Doubles	11/6
Singles	10/6

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		21/6 to 23/–
Household		38/– to 51/–
Coke		22/– to 22/6
NORTHUMBERLAND—		
Best Steams		13/6
Second Steams		12/–
Steam Smalls		10/– to 10/6
Unscreened		13/–
Household		25/– to 37/–
DURHAM—		
Best Gas		15/9
Second		13/3 to 13/6
Household		25/– to 37/–
Foundry Coke		26/– to 29/–
SHEFFIELD—	Inland.	
Best Hand-picked Branch	25/– to 26/6	—
Derbyshire Best Bright House	20/– to 22/–	—
Best House Coal	19/– to 20/–	—
Screened House Coal	17/– to 19/–	—
„ „ Nuts	15/– to 17/–	—
Yorkshire Hards	14/6 to 16/–	—
Derbyshire Hards	14/6 to 16/–	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	7/– to 8/–	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	15/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 19/6 to 20/–		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/6 to 14/–
Ordinary Smalls	12/6 to 13/–
Washed Nuts	17/– to 20/6
No. 3 Rhondda Large	20/6 to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	30/– to 37/–
Furnace Coke (Export)	25/– to 27/6
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	25/9 to 26/3
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	35/– to 37/6
Seconds	28/– to 32/–
Red Vein	23/6 to 27/6
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 27/6
Peas	20/– to 20/6
Breaker Duff	10/– to 10/6
Rubbly Culm	11/3 to 12/3
Steam Coals:	
Large	19/6 to 20/6
Seconds	18/– to 19/6
Smalls	12/6 to 13/6
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. * Under revision at the time of going to press.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Comptoirs.

WHILE in this country steel makers are not so much affected by the crisis as those elsewhere, the situation is, nevertheless, becoming worse and production is being slowed down. In other countries the comptoirs are regarded as offering the only hope of avoiding a collapse, and Belgian firms, which had always looked coldly upon them, are now urging that they should be put into operation during the next two months. The working of the temporary comptoirs, however, has shown that the organisation cannot be carried out so easily as had been supposed. For one thing, it has been found that continental minimum prices cannot be maintained so long as there is competition from British steel, which can be freely offered in foreign markets at below those prices. Before, therefore, the girder and semi-manufactured steel comptoirs can be definitely formed on a satisfactory basis, there must be an understanding with agents of British steel makers, and it is stated that negotiations have been in progress with them for some time past, with results that give promise of reaching a satisfactory arrangement. This optimism may be due to the sincere desire of continental steel makers to come to a working agreement with British producers, which they hope to achieve through agents, but there is a risk of the constitution of the comptoirs being delayed if it has to depend upon a successful issue of the negotiations. On the other hand, the comptoirs are regarded as indispensable for the continental trade, and whether or not the British co-operation can be secured, it is almost certain that they will come into operation at an early date.

Coal Products.

The collieries in the Nord and the Pas de Calais have been successful in meeting the competition of Belgian and German fuel, but they have failed in their efforts to supplant British coal on the western seaboard. They have effected economies by putting down more plant for the manufacture of composite fuels, and erecting power stations using pulverised coal that would otherwise be regarded as waste slack, and distributing electricity over large districts, and they are also distributing coke oven gas to Lille and other towns. Nevertheless, the situation is not satisfactory, for competition has become increasingly keen and stocks of coal have accumulated. For a long while past, coalowners have seen that the future lies more particularly in the scientific treatment of coal, which will always enable them to utilise a surplus production and keep up the price of the fuel. Most of them have been carrying out experiments with all sorts of low-temperature distillation and other processes. The Mines de Bruay have employed the catalytic method and are producing oils, although apparently not yet on an industrial scale. Hopes are now centred upon the production of ammonia, which, it is believed, the northern collieries will be able to supply in sufficient quantities to meet the whole of the home needs. The chemical companies are associating themselves with the collieries, and a company has been formed by the Etablissements Kuhlmann and the Mines de Courrières with the object of utilising the products of distillation.

Tariffs.

The proposed tariff truce continues to meet with opposition from manufacturers, and the matter is dealt with again in the annual report of the Comité des Forges, which declares that, in view of the adverse balance of foreign trade, there can be no stabilisation of import duties until there is a stabilisation of economic conditions. It is declared that the object of the tariffs is to compensate for differences in production costs in France and abroad, and the Comité des Forges states that the higher price of coke in France and the increasing charges on industry render it necessary to raise the duties on some products. That is being done at present, not by any augmentation of tariffs, which can only be accomplished by a Bill, but by modifying the classification and placing some goods which require further protection in a class with a higher scale. The French tariffs are therefore being perceptibly strengthened.

African Air Service.

The Minister of Air has already completed arrangements with the British Government for linking up the service with the East, and he has now signed a convention with the Belgian Government for establishing a service, which will be opened in the autumn between Brussels and the Belgian Congo, with an extension later on to Madagascar. The line will be by way of Paris, Marseilles or Perpignan, Algeria, Gao, Lake Chad, and Elizabethville. Each country will, of course, have control of the service in its own territories. The service will be employed at first for the carriage of mails only.

Foreign Trade.

The contraction of foreign trade has continued for some time past, and during the first four months of the year it accentuated still further, the imports valued at 18,582 million francs, showing a decline of 1796 million francs, as compared with the corresponding period of 1929, while the exports amounting to 15,578 million francs showed a diminution of 834 million francs. The deficiency was partly due to a depreciation of values, for while the imports of "material necessary for industry" increased by more than 2½ million tons to 17,994,930 tons, the value declined by nearly 1½ million francs. The exports of such material, including pig iron and semi-manufactured steel, declined alike in quantity and value. In manufactured goods the imports, amounting to 960,010 tons, increased by more than 30 per cent., while there was an augmentation in value of 934 million francs. The exports of manufactured goods totalled 1,716,572 tons, an increase of 101,395 tons, and the value declined by 323 million francs.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

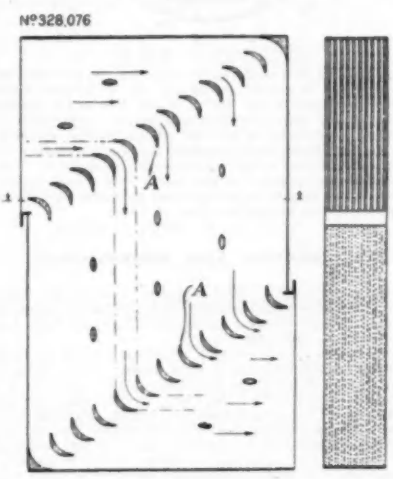
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

328,076. February 26th, 1929.—AIR PREHEATERS, The Underfeed Stoker Company, Ltd., and W. F. Harlow, Africa House, Kingsway, London, W.C. 2.

This invention relates to air preheaters of the plate type, in which the hot flue gases travel on one side of the plates and the incoming air on the other side. It is desirable to give the gases

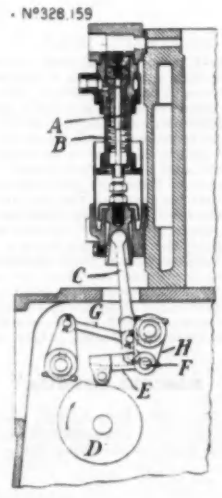


a sinuous path, and that has, according to the inventors, involved a considerable waste of space in past designs. As a consequence, they adopt a rectangular form of heater, as shown in the drawing, and deflect the gases by means of a plurality of vanes A A.—*April 24th*, 1930.

INTERNAL COMBUSTION ENGINES.

328,159. June 21st, 1929.—FUEL INJECTION PUMPS, H. McLaren, Midland Engine Works, Leeds.

This mechanism is intended to provide a convenient means of varying the stroke of the fuel pump and also altering the point of admission. The plunger A of the pump is operated against the pressure of the spring B by the push-rod C. This rod is reciprocated by the cam D and rocking lever E, anti-friction rollers being provided between the moving parts. The rocking

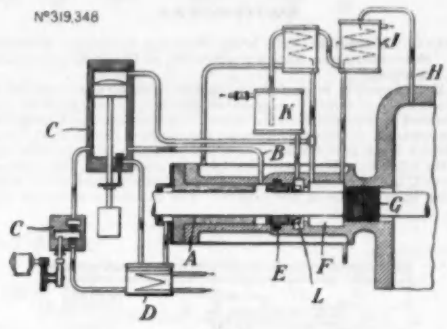


lever E is fulcrumed at F and the length of the stroke of the pump is adjusted by moving the lower end of the push-rod C, along the length of the lever, by means of the linkage G, which may be operated by hand or by the governor. The time of admission is varied by moving the crank H, and consequently the fulcrum F. It will be noted that the path on the lever E on which the end of the push-rod C bears is curved to prevent displacement of the pump piston as adjustments are being made.—*April 24th*, 1930.

TURBINE MACHINERY.

319,348. July 1st, 1929.—SHAFT PACKINGS, Dr. S. Löffler, No. 6 Witzelbenplatz, Charlottenburg, near Berlin, Germany.

This packing is obviously intended for high-pressure and temperature turbines. There is a plain gland A, which also acts as a bearing. It is supplied with oil at a high pressure at B by a pump and accumulator C C. Most of this oil escapes through the gland to the left, is collected in the sump D, and there cooled before being returned to the circuit. A very small portion of the oil escapes to the right, past the floating bush E, into the space F, but is prevented from entering the turbine casing by the screw thread G on the shaft. The space F is also provided with a supply of sealing liquid, presumably condensed steam from the turbine, by means of the connection H and cooling tank J. The tank K serves for the separation of the oil from the water

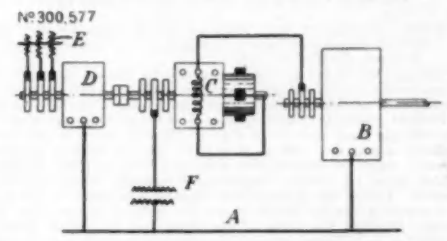


while the impeller L L circulates the sealing liquid.—*April 24th*, 1930.

DYNAMOS AND MOTORS.

300,577. October 24th, 1928.—CASCADING OF INDUCTION AND COMMUTATOR DYNAMO-ELECTRIC MACHINES, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

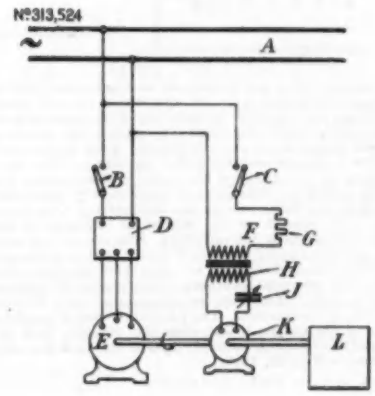
This invention relates to a cascade connection for asynchronous dynamo-electric machines with a compensated independently-driven power factor corrector. For the sake of simplicity, only one phase of the three-phase system is illustrated in the drawing, in which A indicates a three-phase network which is connected up with the stator winding of an asynchronous machine B, which, in turn, is cascaded with the compensated power factor corrector C. The power factor corrector C is excited on its slip-ring side



from the network through an exciting transformer F, with a constant voltage. Alternatively, the power factor corrector may be compound excited from the network and through a current transformer connected in series with the stator of the machine B. The brushes on the commutator side of the power factor corrector are connected with the slip-rings of the asynchronous machine B through the compensating winding. The rotating power factor corrector is driven by the asynchronous motor D, the rotor circuit of which is provided with a regulating slip resistance E. By altering the slip resistance, the torque characteristic of the driving motor is altered.—*April 24th*, 1930.

313,524. June 12th, 1929.—SYNCHRONOUS ELECTRIC MOTOR SYSTEMS, August Karolus, of 5, Linnestrasse, Leipzig, Germany.

This invention relates to synchronous electric motor systems, particularly suitable for use with rapid picture transmission, &c. In picture telegraphy it has been customary to connect the driving motor of the rotating element directly to the lighting or energy distribution system and to feed it with current of similar frequency. It has been found that, when such arrangements are used for rapid picture transmission with high velocities of rotation, and particularly in the case of television or telecinematographic transmission, the high oscillation period of the motor fed with such low periodicity current causes considerable errors and disturbances in the resolution or re-composition of the picture. According to the arrangement of this invention, a higher harmonic having sufficient output is secured



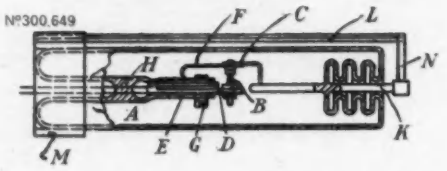
from the low-frequency supply of the feed system, and this harmonic oscillation is used to drive the synchronous motor. The whole of the driving power required for the apparatus can be supplied from this synchronous motor, or this synchronous motor can only take a small quantity of energy in this manner and be used to maintain a main motor in synchronous operation. An alternating current network A supplies, for example, a 50-cycle current in the usual manner. B and C are switches and D is an artificial phase starter mechanism for the main motor E supplied directly with 50-cycle current. The circuit closed by the switch C includes the arrangement for frequency multiplication, in this example a frequency transformer F, the primary current of which can be varied by an adjustable resistance G. The secondary winding H of the iron-cored transformer is tuned with the inductance of the motor K and the adjustable capacity J to a higher harmonic of the feed system, for example, 500 cycles, and the rotor and stator of the motor K are proportionately dimensioned to operate on 500-cycle current. The picture transmission apparatus or television apparatus L may be of any suitable type and therefore is only indicated diagram-

matically; it is coupled with the common shaft of the motors E and K.—*May 1st*, 1930.

SWITCHGEAR.

300,649. November 10th, 1928.—VACUUM SWITCHES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemenstadt, Germany.

The invention relates to a vacuum switch the contacts of which are controlled by a member sensitive to temperature and situated outside the vacuum vessel. In the drawing A indicates the vacuum chamber containing the contact pieces B, C. The contact piece B is attached to a pin D, which is inserted in the glass tube E welded into the vacuum chamber. The contact piece C is carried by the spring F, which is attached to the glass tube E by means of the clip G. The current conductors run

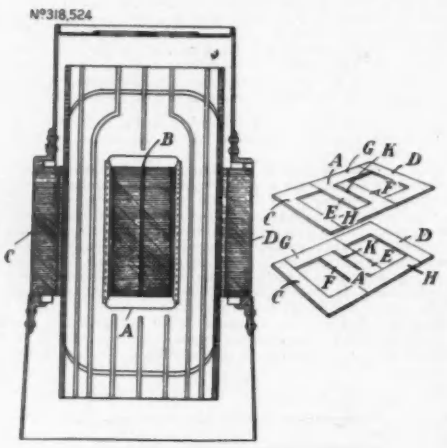


through the sleeve H. The contact piece C can be controlled from the outside by means of the lever K, which passes through an elastic wall, in the form of a waved tube, of the chamber A. Inside the vacuum chamber there are only the contacts B and C, and the metal parts necessary for their attachment. A bi-metallic spring L serves for the control of the contacts, depending on the temperature, and is fastened at its left-hand end to the chamber A by the ring M. At its right-hand end it is firmly connected by means of the lever N with the lever K. On an increase of temperature this curves in such manner that the right-hand end moves downward so that the contact piece C is raised.—*April 10th*, 1930.

TRANSFORMERS AND CONVERTERS.

318,524. September 4th, 1929.—TRANSFORMER CORES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

The general object of this invention is to provide an improved transformer core of the air blast type having a winding leg with an internal ventilating duct. The winding leg A of the core has a vertical internal ventilating duct B, through which some of the cooling air may flow. If this ventilating duct is extended entirely across the core so that it is open at its two opposite vertical edges it divides the core into two separate sections, which must be secured together by suitably heavy clamping means. Unless the vertical side edges of the duct are blocked, too much of the air which enters the bottom of the duct will escape through the sides of the duct and be largely wasted instead of being forced straight up through the duct and through the spaces between the top horizontal portions of the coils of the windings. The invention provides an improved core construction having a ventilating duct which avoids these disadvantages. The core is built up of superposed sectional layers

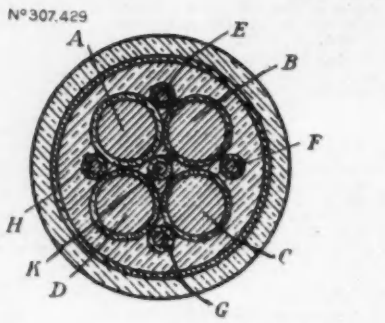


or laminations which are interleaved and assembled into a solid three-legged horizontal type core unit with a vertical ventilating duct through the centre or winding leg of the core, the vertical side edges of the duct being blocked by parts of the core structure to prevent escape of air at these places. Each lamination comprises four L-shaped sections fitted together to form the three leg portions A, C and D, and the yoke portions joining the ends of the leg portions. The sections are similarly arranged in all the laminations, but some of the laminations are reversed in position with respect to the others, as indicated in the side drawing, so that the joints are offset. The central leg portion A is formed of two spaced portions E and F of two of the sections, the other portions G and H of these two sections extending laterally into the yoke portions. The spaces K between the sections E and F form the corresponding duct B after the laminations are assembled. The portions G and H extend across the ends of the spaces B and close the opposite ends of these spaces and the opposite vertical edges of the duct B in the completed core.—*May 1st*, 1930.

TRANSMISSION OF POWER.

307,429. March 6th, 1929.—RUBBER-COVERED ELECTRIC CABLE, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

For current conductors in mines, and in particular for coal cutting machines, a four-line cable of which three lines serve for carrying the three-phase current and the fourth of equal size as an earth line is frequently used. In order to prevent the production of a spark on the rupture of such a cable or its mechanical damage when under current, the cable is provided with a thin auxiliary line which is inserted in the current circuit of a switch apparatus, the arrangement being such that the thin auxiliary wire ruptures before the working or earthing conductors and that on the rupture of the thin auxiliary line the cable loses its potential. The invention relates to a cable with current conductors for subterranean purposes with lines carrying useful current and several auxiliary conductors, with which a rupture of the conductor under current is avoided owing to the fact that the arrangement of the auxiliary conductors in relation to the main conductors is so effected that a rupture of these auxiliary conductors must take place upon external mechanical actions. This is effected by the fact that auxiliary conductors are twisted together over the main cores with opposite direction of twist. Should, then, one of the auxiliary lines be prematurely broken, one of the others can be used in its place. A B C are three working current mains which are composed of thin wires and are insulated by one or more coatings of rubber. D is the earth line constructed in the same manner. E F G H are four auxiliary lines, each one of which consists of several thin copper wires which are coated with one or more layers of rubber. Both the

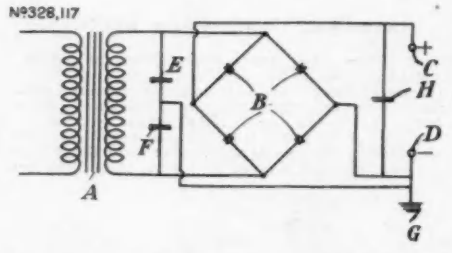


auxiliary lines as well as the main wires may be provided with a ribbon winding or cotton sheathing. K is another auxiliary conductor arranged in the centre of the four main conductors which is of the same construction as the other wires. The cable core so produced is covered with a ribbon winding and rubber coating in the usual manner, on which a further ribbon winding and a second rubber coating may be applied. Between the two rubber coatings a further earth wire sheathing may be arranged, which may be separated from the outer rubber coating by a further ribbon winding.—*May 1st*, 1930.

TELEGRAPHS AND TELEPHONES.

328,117. April 20th, 1929.—RADIO RECEIVING SYSTEMS OPERATING IN CONJUNCTION WITH ALTERNATING-CURRENT MAINS, Harold Vincent Carlisle and Ferranti, Ltd., both of Hollinwood, Lancaster.

This invention relates to radio receiving systems operating in conjunction with alternating-current mains. In the operation of such systems, considerable difficulty arises owing to a hum commonly termed the "tunable hum," which frequently occurs, especially when the system is sharply tuned. Various measures have been adopted to minimise this disturbance, *e.g.*, by the disconnecting of the system, including batteries, if any, from earth or loosely coupling the aerial coil, or, again, by the connecting of a condenser from one side of the mains to earth. The latter measure is not altogether desirable, since in certain circumstances quite an appreciable current may pass to earth by way of the condenser, thus heating the latter and rendering it liable to breakdown. According to the invention, additional or alternative and improved measures are provided in order to minimise or eliminate the disturbance in question. In the diagram an alter-

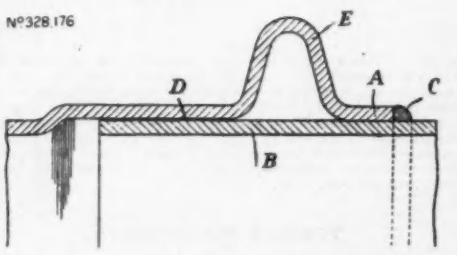


nating-current mains power transformer is shown at A. To the secondary terminals is connected a bridge, in the arms of which, rectifier devices B are incorporated, the output terminals C D of the bridge being connected through a smoother circuit—not shown—say, to the high-tension circuit of a radio receiving system. Across the terminals of the secondary winding of the power transformer there are two condensers E F, of about 0·1 microfarad each, and there is a connection made from the interconnecting point of these two condensers to the negative lead from the output terminals of the rectifier bridge and the lead is usually earthed at G. Another condenser H may be connected across the output terminals of the rectifier bridge. With such an arrangement the interfering hum is almost entirely eliminated. The rectifier devices may conveniently be electrolytic rectifiers, copper oxide rectifiers, or copper sulphide rectifiers. When the arrangement is applied to the supplying of current for the heating of filaments in thermionic valves, the capacity of the condensers E F is increased somewhat, *e.g.*, to a value of about 1 microfarad each.—*April 24th*, 1930.

MISCELLANEOUS.

328,176. August 8th, 1928.—PIPE JOINTS, Mannesmannröhren-Werke, 1B, Berger Ufer, Düsseldorf, Germany.

This pipe joint is made by shrinking the end of one pipe A



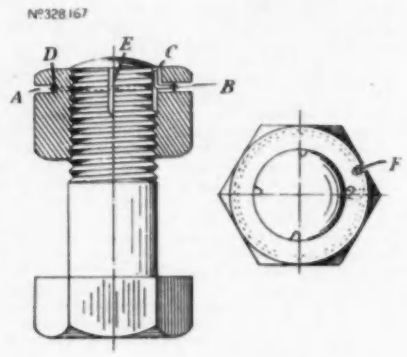
on to the other pipe B, and then welding at C. At D a slight clearance is allowed, and the corrugation E provides for expansion and contraction without stressing the weld unnecessarily.—*April 24th*, 1930.

327,951. December 12th, 1928.—MANUFACTURE OF LIGHT-EMITTING ELEMENTS FOR ELECTRIC LAMPS, Dr. Alfred Schmid, of 5, Pelikanweg, Basle, Switzerland, and Metropole Developments, Ltd., of 4B, Frederick-place, Old Jewry, London, E.C. 2.

This invention relates to the manufacture of filaments for electric lamps and it consists in securing the result of an even cooling throughout the length of the filament in an improved way. The filament is circular at the ends, but is flattened at the centre, so that although the cross-sectional area is constant throughout, the superficial area intermediate of the ends of the filament is increased. This ensures a better radiation. The filament is also more evenly cooled down at the flattened region, as at that point it gives off more energy and cannot burn through at the middle. The flattening is greatest in the middle and gradually changes to coincide with, or approximate to, the usual circular form at the ends.—*April 14th*, 1930.

328,167. July 17th, 1929.—LOCK NUTS, P. Brunelli and A. Biasiotto, 123, Via Dei Gracchi, Rome, Italy.

In this lock nut a groove A is cut round its periphery, and has a radial hole B communicating with an axial groove C. Into this groove a spring wire D is slipped. The threaded part of the



bolt is cut with a series of grooves E, which are rounded on one side and sharp cornered on the other. The wire consequently slips past these grooves when the nut is turned in the tightening direction, but binds fast in the reverse. For removing the nut a pin is inserted into the recess F to lift the wire out of engagement.—*April 24th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ROYAL AERONAUTICAL SOCIETY.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Development and Progress of Aircraft Engines," by Mr. H. R. Ricardo. 6.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W. 1. Discourse, "The Metal Crystal," by Sir H. C. Harold Carpenter, F.R.S. 9 p.m.

TO-DAY AND SATURDAY, MAY 31ST.

INSTITUTION OF WATER ENGINEERS.—Summer meeting in London. For programme see page 542, May 16th, 1930.

MONDAY, JUNE 2ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. General meeting. 5 p.m.

MONDAY TO MONDAY, JUNE 2ND TO 9TH.

INSTITUTION OF GAS ENGINEERS.—Conference at Leeds. For programme see issue May 9th, 1930, page 528.

THURSDAY, JUNE 12TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Northern Irish District meeting, Manager's office, Corporation Gasworks, Ormeau-road, Belfast. 3 p.m.

SATURDAY TO SATURDAY, JUNE 21ST TO 28TH.

ROYAL SANITARY INSTITUTE.—Congress at Margate. For programme see page 534, May 9th, 1930.

TUESDAY, JUNE 24TH.

ADVERTISING CONVENTION, 1930.—Industrial Press Session Luncheon, Royal Victoria Hotel, Hastings, after which a number of speakers will give their views on various matters connected with the trade and technical Press:—Professor Henry Clay, "British Industry's Message to the World;" Mr. Holbrook Jackson, "The Voice of Industry—the Trade Press;" Mr. C. Pinkham, "The Service Expected from a Trade Journal;" Mr. P. Best, "The Trade Journal as a Link between Manufacturer and Distributor."

WEDNESDAY TO WEDNESDAY, SEPTEMBER 3RD TO 10TH.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—Bristol meeting. The presidential address, by Professor F. O. Bower, will deal with "Size and Form in Plants." Evening discourses will be given by Professor E. V. Appleton, F.R.S., on "Wireless Echoes," and by Dr. R. E. Slade on "The Nitrogen Industry and our Food Supply." Evening receptions and excursions to points of scientific interest, works, &c., in the locality will be arranged.

THURSDAY TO SUNDAY, SEPTEMBER 4TH TO 7TH.

INTERNATIONAL CONGRESS OF CONSULTING ENGINEERS.—Fifth Congress at Vienna.

AN INTERNATIONAL EXHIBITION OF CHEMICAL APPARATUS.—An International Exhibition of Chemical Apparatus and Chemical Engineering is to be held at Frankfort-on-Main from June 10th to June 22nd. The exhibits will cover a floor space of some 20,000 m. A guide to the Exhibition in the form of the *Achema Jahrbuch* for 1928–1930 has been prepared by Dr. Max Buchner in collaboration with other specialists. It reviews the present position and recent developments of chemical apparatus and chemical engineering, and is to be obtained from the Deutsche Gesellschaft für Chemisches Apparatewesen-E.V., of Seelze, near Hanover, and Berlin.